A TREATISE

ON THE

PARASITES AND PARASITIC DISEASES

OF THE

DOMESTICATED ANIMALS

BY

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PREFACE TO THE SECOND EDITION

THE second edition of Fleming's translation of Neumann's *Traité des Maladies Parasitaires non Microbiennes des Animaux Domestiques* has been carefully revised and brought up to date. The arrangement of the chapters remains undisturbed, but the footnote references to authors have been removed from the pages and placed together at the end. In places the terminology has been altered—a change which might have been extended but for the fear that further interference with familiar names would cause inconvenience to many who may consult this work.

In the preparation of this edition I have received much assistance, for which I desire to record my indebtedness and grateful thanks: to the author of the original, Professor Neumann, for his untiring helpfulness in reconstructing the chapter on the Dermatomycoses, and in furnishing most of the additions and corrections elsewhere; to Professor McFadyean—always accessible and ready with advice on difficult points—for permission to transcribe portions of his published articles on parasites, and to copy Figs. 141, 142, 143, and 144; to Dr. Salmon, Chief of the Bureau of Animal Industry, U.S.A., for many valuable publications on parasites; and to Dr. G. H. F. Nuttall, Cambridge University, for a copy of his Critical and Historical Study of the 'Rôle of Insects, Arachnids, and Myriapods as Carriers in the Spread of Bacterial and Parasitic Diseases of Man and Animals.' I have also to thank my colleagues—Professor Woodruff, for assistance with the pages on Ringworm, and Mr. T. C. Graves for revising the Index.

J. MACQUEEN.

ROYAL VETERINARY COLLEGE,
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PREFACE TO THE FIRST EDITION

(ABRIDGED)

THE value of such a work as this of Professor Neumann is amply testified to by the fact, that the first edition was exhausted in less than three years, while the author received the Vernois Prize from the Académie de Médicine in 1889, and the gold medal of the Société Nationale d'Agriculture de France; the War Minister of France has also authorized its issue to all the mounted corps and the military schools and establishments. No better evidence of its great merits could be adduced, nor can stronger proof be afforded of the recognition and encouragement such labours meet with in France. Professor Neumann, with the greatest courtesy and generosity, not only gave me permission to translate his admirable work, but provided me with corrections and additions which could not appear in the body of his new book. For all this goodness and attention, I beg to tender my estimable friend warmest thanks.

There is no work in English to be at all compared with this, so far as veterinary medicine is concerned; and even in human medicine—English or foreign—there is none so comprehensive and complete. In his preface, Neumann states: 'Those who have studied the subjects so numerous and varied, the substance of which is given in this book, will have had reason to be astonished at the multiplicity of the works in which they are treated, and the almost innumerable documents of which they are constituted. They will also have had cause to regret more than once that, in our country at least, no one has ventured to give a didactic tableau of the injury caused by parasites to the health of the domesticated animals. Having, as much as anyone, had to regret the existence of this void, we determined to fill it. Truly, this attempt is not altogether without precedent; but none of the French or foreign works to

which we have referred—excellent though some of them are—could be accepted as a model; as some were limited to the "entozoa," others to the parasites of the skin, certain of them prematurely included microbic diseases in their list, or confined themselves to the parasites only—neglecting too much the host and the mischief they caused; while the majority, if not all of them, adapted their plan to the taxinomic requirements of zoology and botany.

'As we had in view more particularly the damage done to health—the parasitic diseases—we deemed it useful to establish the order to be followed according to the nature of the organs invaded; and this has been the predominant idea throughout the work—the rare deviations therefrom which had to be made being of no importance, as they will cause no trouble or hindrance to the attentive reader in determining the character of the parasites he may meet with.

'In dealing with the parasitic diseases of our domesticated animals, no notice has been taken of those very small and subtle parasites usually designated "microbes," which belong to the vast class of Schizomycetes; for, notwithstanding the incontestable interest that invests them, as a whole, in the parasitism of animals, it appeared advantageous to omit the virulent diseases. One decisive reason, among others, justified this omission; for if among these maladies there are some the parasitic origin of which is established, there are many others, unfortunately, for which the same cannot be said, though they are better known, and cannot be separated from them with regard to symptoms, course, lesions, conditions of contagion, sanitary police, prophylactic measures, etc. The diseases which we here treat of are nearly all due to relatively large parasites, which might be designated macro-parasites.

'The domestic animals dealt with in this book—mammals and birds—are almost exclusively species belonging to our country, as the observations regarding parasitism more especially belong to them; the species special to Asia, Africa, and America have, in this connection, an interest too secondary to warrant us in further extending our already very extensive work. Therefore it is that they have only received rare and brief notice.

'Although pathology has been more especially kept in view, we have not confined ourselves to an enumeration of the troubles engendered in the economy by the organisms that invade it. In order to facilitate diagnosis, we have added to the study of the

parasites—properly so called—that of the commensals which are so frequently met with; and we have been compelled to include all the living forms observed on the surface or in the texture of organs, whether they be common or rare, frequent or exceptional.

'As it is not always easy, in presence of an intrusive species, to allot it to parasitism or commensalism, and as numbers are, in this matter a powerful element in distinguishing it, the determination of a parasite is singularly aided by comparing it with species having the same habitat. The mention which accompanies each of these gives the measure of its importance.

'In order to render a nosographical account of the parasitic disorders intelligible, it is absolutely necessary that zoological, and sometimes botanical, information be had recourse to. Generally speaking, this has been reduced to the strictest minimum, as the reader can find in other treatises or special works any further information he may require.'

I have only to express the hope and desire that the subject of parasitism, which has been so closely and advantageously studied by members of the veterinary profession—more especially in France, Germany, and Italy—will now receive greater attention from those in English-speaking countries generally—countries which cover such a large surface of the globe, and therefore offer such excellent opportunities for extending our knowledge in this important section of biology and sanitary science.

The metric system of measurement has been retained, as it is the most convenient, and is now generally adopted in scientific treatises. The introduction of the micromillimetre (μ) is a great advantage in dealing with very minute objects. The title of the work I have also taken the liberty of slightly altering, in order the better to indicate its scope; as it treats not only of parasitic diseases and their treatment, but lucidly, if briefly, of the parasites themselves—an advantage which will be appreciated by those who wish to gain some knowledge of them, and learn to identify them.

GEORGE FLEMING.

ST. JOHN'S, LONDON,
March, 1892.

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A TREATISE

ON THE

NON-MICROBIC PARASITIC DISEASES OF THE DOMESTICATED ANIMALS

INTRODUCTION

Of the diseases which are engendered in the external media surrounding animals, many are due to inferior organisms contained in these media—organisms in various stages of development, from the egg to the perfect individual. The recent and uninterrupted progress of science daily increases the domain of this section of pathology, and incessantly tends to include disorders which, until lately, were ascribed to purely physical causes. Hence has arisen a special branch of science, *Parasitology*, which has a distinct object and methods, and possesses a particularly suggestive interest.

In the immense laboratory of living matter representing the organic world, the conditions of nutrition are so framed for animals, and also for non-chlorophyllous plants, that their aliment is exclusively composed of organic substances. The majority of these organisms subsist on lifeless matter ; but there are many that prefer to derive their nourishment from living beings, and so obtain it during a part, or even the whole period of their existence. When the relations between size and strength are such that the consumer is inferior to its victim, the former becomes the parasite of the latter.

Parasitism is, therefore, only a particular instance of *Symbiosis* (De Bary) ; and the various forms of life in common of different organisms are so named, there being distinguished ***mutualism, commensalism,*** and ***parasitism*** (P. J. Van Beneden).

In ***mutualism***, or ***mutualistic symbiosis***, the two beings in contact form a real association or union, which is beneficial to both. In ***commensalism*** one of the two alone profits by this union, in which it finds a refuge, and also, without injuring its co-symbiot, more favourable, if only contingent, conditions for existence. In ***parasitism***, or ***antagonistic symbiosis***, only one of the organisms, again, gains by the union, which affords it an assured shelter and subsist-

ence—sometimes only the latter—most frequently at the expense of its co-symbiot, which in this case becomes its *host* (or *bearer*). It is in this sense that we adopt the word 'parasite,' and so give it an extension which will be at least justified by the aim of this work.

The *Parasites* (παράσιτος, eating beside or with another, from παρά, beside, and σῖτος, food) which live on the domesticated animals (Mammals and Birds) belong to the vegetable and animal kingdoms. All the vegetable parasites (*Phytoparasites*) are fungi; all the animal parasites (*Zooparasites*) belong to the Invertebrata.

Vegetable Parasites.—The majority of the parasitic Fungi of the domesticated animals are included in the group—order or family—of *Schizomycetes*, *Bacteria* or *Bacteriaceæ*. They are formed of a single cell destitute of nucleus, the homogeneous protoplasm of which is generally colourless, and is enveloped in a thin membrane. Their essential mode of multiplication is by division, nearly always transversal, and rarely in two, or even three directions. Among them are found the most minute organisms. If, indeed, some of them may measure two to ten millimetres in length, there are many that reach the limit of the magnifying power of the best microscopes. All the inferior organisms which are now popularly designated *Microbes* belong to the Schizomycetes. The considerable part they play in the general economy of Nature is every day rendered more evident by the progress of science, and there is a particular tendency to give them a more and more preponderating influence in the etiology of infectious or contagious maladies—such as Anthrax, Glanders, Tuberculosis, Swine-plague, Tetanus, Fowl Cholera, Typhoid Fever, etc. Pathogenic microbes, or their chemical products (toxines), are now considered the virulent agents proper to each of these affections; and their multiplication within the body of an infected animal affords an explanation of the characteristic processes of these diseases.

Their rôle in pathology, the special nature of the disorders they occasion, their biological physiognomy, the delicate methods required in their study, and the different points of view from which they may be considered, separate them distinctly from the other parasites. It is for this reason that they are not comprised in this work, which is devoted only to parasites relatively gigantic for the most part, localized in one or more organs or tissues, and never intimately mixed up in the fluids. But it must be stated that there are between these two large groups of parasites some intermediate ones: Schizomycetes, such as the Sarcina; the *Micrococcus* of the funiculus; the *Actinomyces bovis*, etc., which very closely localize themselves; and macroparasites which, at certain phases of their development, invade the circulating fluid—as the embryos of the hæmatozoa. Notwithstanding these few exceptions, there is more advantage than inconvenience in separating the study of these two groups of parasites. Consequently, only a small number of parasitic fungi will be referred to in this work.

Animal Parasites.—Three sections only of the animal kingdom contain the parasites of the domesticated animals; these are the *Protozoa*, *Worms*, and *Arthropodes.*

A. The **Protozoa** are very small, often microscopic creatures, formed of a single and more or less complex cell, and possessing neither differential organs nor tissues. Their reproduction never requires the intervention of male or female sexual elements (spermatozoids or ova), but takes place by fission, budding, or sporulation; at most, it may sometimes be preceded by the definitive or transient fusion of two or more individuals (*conjugation*).

They are divided into five classes, of which only two (*Sporozoa*, *Infusoria*) contain parasites of the domesticated animals.

The *Sporozoa* are parasitic Protozoa provided with a nucleus, and generally limited to the adult age by a hairless cuticle which has no flagellum or suckers. They are reproduced by *spores*, resulting from segmentation of their protoplasm or sarcode. They are often designated *Psorospermiæ*. Balbiani has arranged them in five orders: *Gregarina*, *Coccidia* (*Psorospermiæ oviformes*), *Sarcosporidia* (*Psorospermiæ utriculiformes*), *Myxosporidia* (*Psorospermiæ of Fish*), and *Microsporidia* (*Psorospermiæ of the Arthropodes*). The Psorospermiæ which concern us are the Coccidia and Sarcosporidia. The first chiefly inhabit the digestive apparatus, the second are found exclusively in the muscles.

The *Infusoria* are Protozoa provided with a nucleus, and, generally, a cuticle bearing cilia, flagella, or suckers. They are divided into three sub-classes according to the nature of their appendages. Infusoria are more particularly found in the digestive apparatus, or its dependencies, of the domesticated animals: they belong to the Flagellata or Ciliata.

B. The **Worms** are Invertebrata, with a soft contractile body, which is symmetrically bilateral and non-articulated, or is markedly divided into a linear series of similar (homonomous) rings, is always destitute of articulated limbs, and is provided with a system of excretory organs in pairs (aquiferous vessels) opening externally.

This section contains a vast collection—the *Helminthes* (*ἕλμινς*, worm)—which do not form a very natural zoological class; but from our point of view it is useful to bring them into one group, because of the analogies in their *habitat*, and their mode of action. These are the Worms which are generally parasitic; they are cylindrical or flattened, are always destitute of a ventral chain of nerve-ganglia, and have no rotatory apparatus for locomotion. All those we treat of belong to this group, with the exception of a small number which pertain to the *Annelida*.

The Leeches (*Hirudines*) have the body cylindrical or flattened, are distinctly ringed, and have always a ventral chain of nerve-ganglia, an œsophageal collar, a cerebroid ganglion, and a blood-vascular system. The *Hæmopis sanguisuga* and other leeches will be considered with the parasites of the mouth and pharynx.

The *Helminthes* demand a more detailed description. Simple in

their organization, they are—especially as parasites—unprovided with sensory organs, and their feeble respiration is always carried on through the integuments. Designated in many works as *Entozoa*, *intestinal Worms*, etc., although they may be found in various organs, they are divided into two classes : the *Platyhelminthes*, with bodies generally flat ; and *Nemathelminthes*, whose bodies are nearly cylindrical.

The *Platyhelminthes* or *Platodes* comprise three orders : *Cestoda*, *Trematoda*, and *Turbellaria*. The first two only are limited to a parasitic existence. Nearly all the species are hermaphrodite.

The *Cestoda* or *Cestoïdes* (κεστός, band, and εἶδος, form) are Platyhelminthes whose bodies are nude in the adult condition, ribbon-shaped, nearly always segmented, and provided at one extremity with organs of fixation—suckers or hooks ; they have no digestive apparatus. In the adult state, they live in the intestines of the higher animals ; but before that period they undergo a certain number of metamorphoses and migrations, which are often effected in the most diverse organs of different hosts.

The *Trematoda* (τρηματώδης, perforated) are Platyhelminthes, the bodies of which are nude, soft, and non-segmented, generally foliaceous, and furnished with one or more suckers ; they have a digestive canal having a single opening and no anus. Those which concern us live as parasites in the interior of the body of their host (endoparasites) and belong to the sub-order of *Distomea*. They possess at most two suckers, of which the anterior is oval.

The *Nemathelminthes* (νῆμα, thread) or *round Worms*, in which the sexes are nearly always separate, comprise two orders : *Acanthocephala* and *Nematoda*.

The *Acanthocephala* have no digestive canal, and have a protractile proboscis armed with hooks. They include only the *Echinorhynchus*, which, in the adult state, lives in the digestive canal of Vertebrates.

The *Nematoda* or *Nematoïdes* have a digestive canal, generally complete, with two openings. They are elongated, frequently slender, and even filiform. Their number is considerable, and they are found in all the organs of the domesticated animals, with the exception of the bones.

C. The **Arthropoda** are Invertebrates, symmetrically bilateral, formed of dissimilar rings (heteronomous), and always provided with articulated limbs. There are four classes : *Crustacea*, *Arachnida*, *Myriapoda*, and *Insecta*. The Arachnida and Insecta alone contain species which are parasitic in the domesticated animals.

a. The *Arachnida* are air-breathing Arthropoda, respiration being effected by a trachea and lungs, or by the cutaneous surface ; the head is usually fixed to the thorax (cephalothorax) ; there are two pairs of masticatory appendages (gnathites), four pairs of feet, no wings, and an apodous abdomen. Of the orders into which they are divided, two alone include parasites of warm-blooded Vertebrates : these are the *Linguatulida* and the *Acarina*. The first live, when

adults, in the air-passages, but in the larval state they infest the internal organs. The parasitic Acarina almost exclusively inhabit the surface or the substance of the skin.

b. The *Insects* are air-breathing Arthropoda, with a trachea, having their bodies divided into three distinct parts (head, thorax, and abdomen), the head carrying a pair of antennæ, the thorax three pairs of legs, and most frequently two pairs of wings. There are many orders, only two of which—the *Diptera* and *Hemiptera*—contain parasitic species, nearly all of which live—at least, in the adult state—on the surface or in the substance of the skin.

Habitat of the Parasites.—Parasites live on the surface of the skin or in the depth of organs. The first are named *ectoparasites*, and the second *endoparasites*.

The ectoparasites are vegetable and animal. The first are called *dermatophytes*, and the others *epizoa* or *ectozoa*. The two last names are generally, however, more particularly applied to the apterous Insects known as *Pediculidæ* and the Lice-like *Ricinidæ*. The other animal ectoparasites are the Acarina and Insects.

The vegetable endoparasites comprise all the phytoparasites other than the dermatophytes. The animal endoparasites are the Sporozoa, the Infusoria, and the Worms; there are also the larvæ of certain Insects, and notably those of several Œstridæ. The term *Entozoa*, which is quite suitable, is applied almost exclusively to the Helminthes.

Degrees and Mode of Parasitism.—Parasitism occurs in various degrees. It may be *facultative* or *obligatory*. Facultative or *occasional parasitism* (Leuckart) is rarely met with beyond the Fungi, and particularly the Schizomycetes, a large number of which may develop indifferently in lifeless media, in organic matter undergoing decomposition, or even in living bodies. Nearly all the parasites embraced in our study present obligatory or *constant parasitism* (Leuckart); their development necessarily admits of it, at least during a portion of their existence.

From this point of view, parasitism is *transitory* or *permanent*. It is transitory for the creatures which, during a portion of their life, may be nourished external to an animal organism; and sometimes it may take place only during early age—as in the case of the Œstridæ, of which only the larvæ are parasites; at other times, it is only at adult age—such are the Anchylostomes, the Ixodinæ, and the Chigoe. Permanent parasitism extends from the hatching of the egg and liberation of the embryo, to the phase of reproduction in the adult. The majority of the Entozoa undergo permanent parasitism.

Parasites may also be *fixed* or *erratic*, according as they have a narrowly defined habitat and cannot spontaneously pass from one host to another (Helminthes, Linguatula, larvæ of the Œstridæ), or enjoy a more extensive domain (Lice, Ticks, psoric Acarina, Fleas, Bugs, Gnats, Leeches, etc.).

For the latter—obligatory and erratic parasites—parasitic life may be essentially *intermittent*, that is, when they only visit their host to obtain nourishment, leaving immediately afterwards. Such are the adult Diptera (Stomoxes, Hæmatobia, Tabanidæ, Simuliidæ, Gnats, etc.), which, when they are gorged with blood, forsake their entertainer and fly to other occupations. Parasitism is *continuous* for those which remain permanently on the surface of their host for generations: Lice and psoric Acari. *Remittent* parasitism is an intermediate form between intermittence and continuity, and examples are furnished by the erratic parasites which breed away from their hosts, and are not so closely attached to them—such are Lice, Hippoboscidæ, Hæmopis.

The mode of reproduction is, in fact, one of the principal factors that determine the conditions in which parasitism shall take place; and in proof of this, there is the profusion with which the germs are produced—this tending to compensate for the many causes of destruction to which they are exposed.

With regard to intermittent and remittent parasites, reproduction is independent of the host, copulation usually occurring far from the latter, and ovulation always.

Transient parasitism often commences at ovulation, and terminates at adult age (larvæ of the Œstridæ).

Independently of the cases mentioned above (continuous parasitism), in which generations succeed one another indefinitely in the same host, there are others where the eggs, deposited in the body of the entertainer, are soon expelled, and must remain external until they reach the maturity indispensable to hatching. This may take place either in an external medium, or in a new host into which the eggs may have passed by various channels. The Helminthes offer in this respect extremely varied types, of which we shall only notice those relating to the parasites of the domesticated animals, or to neighbouring and better known species.

Sometimes complete evolution of the species only requires one host, sometimes it demands two, successive and, in general, specifically different hosts. Parasites may therefore be termed *monoxenous* (μόνος, single, and ξένος, host) or *heteroxenous* (ἕτερος, different, ξένος, host).

I. *Monoxenous Parasites.*—*a.* The ovum having been evacuated by the host, the embryo is developed within the shell, and, while it is still there, passes into a new and definitive host. Examples: *Oxyuris vermicularis, Trichocephalus affinis.*

b. The embryos, having left their shell, live in water or moist soil, and are nourished and grow there; but they are not complete—that is to say, sexualized—until after they reach the body of their host. Example: *Anchylostomum.*

II. *Heteroxenous Parasites.*—These pass by an *intermediate* or *transitory host*, in which they cannot attain their complete development; consequently, this first host must become the prey of a second or *definitive host*. The choice of the latter is subordinate to

its habits. This passing of the heteroxenous parasites from one host to another is named *transmigration*.

a. Some of the embryos pass to the intermediate host; others may develop in the host in which they are hatched. Example: *Ollulanus tricuspis*. This type serves as a transition between the monoxenous and heteroxenous parasites.

b. The embryos are hatched in the body of the host which shelters their mother, and invade its tissues; they attain the adult state in a second host. Example: *Trichina* (*Trichinella*) *spiralis*.

c. The eggs are expelled from the body of the definitive host, and the embryos—free or yet in the shell—pass to the intermediate host, where, after a first development, they give rise, by asexual generation, to individuals different from their parent. It is incumbent that these individuals make one or more migrations, in order to realize the definitive form which terminates the cycle of their development. These parasites, therefore, represent what has been termed *alternate* or *heterogeneous digenesis*. By their faculty of multiplication in the intermediate host, they realize more exactly than the others the heteroxeny of the Fungi. Example: *Tænia cœnurus*, which has the Sheep for a transitory host, in the brain of which it is developed as an agamous form of cœnurus—and for definitive host the Dog, whose intestine it inhabits while acquiring the adult state.

Lastly, there are many parasites the metamorphoses and migrations of which we are still ignorant.

In general, each species of domestic animal has its parasites, which are only found in it, or, at least, do not thrive in a different species, and soon leave it. There is between the inferior being and its host an intimate correlation, an exact subordination, which we may recognise without being able, in many instances, to determine the conditions. Parasites which escape them are precisely those for which parasitism is not imperative, and which only appear in the domestic animals intermittently; such are the majority of the Diptera, which, in the perfect state, attack the Horse, Ox, and Sheep indifferently; and certain species of Fleas that pass readily from Man to the domestic animals, or inversely, or from one Bird to a different Bird. The Entozoa are more strictly limited to determinate species, and the exceptions to this rule are rare. One of the most remarkable is furnished by the Trichina, which, in the larval state, finds in the muscles of very diverse species a favourable habitat. Many of the cystic forms of Tænia are equally rather indifferent to the specific nature of their host, but this does not apply to the sexual state.

The subordination of the parasite is not confined to the host, but usually extends to the habitat. In general, the skin has its parasites, which are unlike those of the intestine, and the latter differ from those of the air-passages. Nevertheless, the forms which invade the parenchymatous organs often appear indifferently in one or another (liver, spleen, lungs, kidney, etc.); such is the cystic form of

Tænia echinococcus. Certain nematode Worms—*Spiroptera sanguinolenta, Filaria papillosa*, etc.—may also be met with in various organs.

It may happen that, at an early age, a parasite attacks a host which is not suitable to its development; this, according to Davaine, is a *foreign* or *accidental host;* or, the host being normal, the parasite has penetrated organs improper to its evolution or growth. In both cases it is a *stray parasite*. It is called *erratic* when it is found in the adult state in an organ different from that which constitutes its normal haunt.

Etiology of Parasitic Diseases.—General ignorance at one time prevailed with regard to the origin of parasites. Certain of them, because of their small size, escaped observation, and the maladies they occasioned were relegated to those sections of pathology into which the character of their lesions seemed to warrant their being placed; such were the microbic diseases, the dermatomycoses, scabies, etc.

The others were considered as the products of a spontaneous generation in the midst of organic matters, under the influence of heat, fermentation, putrefaction, etc. These views were discredited towards the beginning of the last century, when precise notions regarding the complex structure and reproductive organs of a large number of parasites began to be entertained. But until the early years of the nineteenth century, distinguished helminthologists, such as Rudolphi and Bremser, clung to the old doctrines, and Burdach even professed them in 1830, in his *Traité de Physiologie*.

When, in 1842, Steenstrup made known his theory of alternate generation, and a few years afterwards Von Siebold, Van Beneden, Küchenmeister, and others published their significant researches on the generation of flat Worms, the early theories were overthrown, and the necessity for an anterior germ for parasites, as for all other creatures, was universally admitted. The ingenious experiments of Pasteur prevailed against all refractory opposition, and peremptorily established the fact that spontaneous generation could not be invoked, even for the infinitely small parasites or microbes.

Our knowledge of vegetable parasites was later in being perfected, for they were not rendered evident without the assistance of the microscope. The demonstrative labours of Tulasne in 1847, and of De Bary, having proved the nature of the parasitic Fungi of plants, the doctrine of parasitic mycoses in animals obtained a solid basis. A great share of this important acquisition belongs to Ch. Robin, who has shown in a classical work on the subject the considerable part played by these lower organisms.

Another theory invoked by the ancients to explain the origin of parasites—at least, the intestinal Worms—was to regard them as hereditary; and it is to be noted that, ignorant of the nature of these creatures, they only knew of three kinds of Worms in Man, and, it may be said, none in the domestic animals. When the researches of

naturalists had established the great number of parasites that a single individual may harbour, it became incumbent to renounce an explanation that could not satisfy sensible minds. All that can be admitted is that the fœtus may be invaded—like the maternal organism, and for the same reason—by embryonic worms, which the circulation carries to every part of the body.

The propagation of parasitic diseases is subordinate to the conditions of existence of the parasites.

The eggs deposited by Worms in the intestinal canal, biliary or urinary passages, are expelled with the excremental contents of these. Those of the air-passages are carried outwards by the vibratile cilia of the epithelium (Davaine), and more especially by coughing and husking. Frequently fragments of, or even entire Worms are thus expelled, and these, by a process of natural disintegration, yield the ova they contain to external agents.

These ova have various destinations. The majority are lost by exposure to unnatural dryness or humidity. Those which are more fortunate may have to wait a long time—months, and sometimes even years—before they can reach the body of a new host; sometimes it is the ovum itself, at other times the hatched embryo, that finds a new home; often it is a larva intermediate between the embryo and the adult, and occasionally an individual of a new generation, which remains independent for a longer time.

In this way the ova of the *Ascaris lumbricoides* and the Trichocephalus of Man may wait four years for the chance that will bring them into their natural host. The embryo formed in their interior maintains a latent existence, which terminates when it arrives in the digestive canal, where it pierces the shell of the egg, which has become softened by the intestinal juices.

The duration of the period of confinement of the embryo in the egg varies with the species. With the ovoviviparous parasites, hatching takes place with the laying—as with Trichina, and the majority of the Strongyles inhabiting the air-passages. This more or less protracted duration of intra-ovular life corresponds to the more or less easy migration of the future Entozoön.

'The conditions which the ovum expelled from the organs of its host encounter, are generally related to the mode of life of this host; for in a great number of cases the ovum ought to develop, or to complete its development, when free. If the host lives in water or on a more or less arid soil, it is in one or other of these conditions that the ovum produces its embryo. The ova of certain Entozoa perish without developing, if they are in a humid medium; but others, on the contrary, die if they are placed in a dry medium' (Davaine).

Besides, in certain species the ova have only a very thin shell, while in others it is thick and resistant; and these differences are related to the durability of the ova after they are laid. In general, the first are hatched in the surrounding media, and infection takes place by the embryos (Ex.: *Sclerostomum*); the thick-shelled ova

pass, on the contrary, intact into the digestive canal of the host (Ex.: *Ascarides, Trichocephalus*).

The embryo, set at liberty in the digestive canal, finds its way to the compartment suitable to its specific nature; or it passes through the intestinal wall, and, either by reptation or by means of the circulation, it attains those organs which alone favour its ulterior development. In this way are the proscolices of Tæniæ, and the embryos of Trichinæ and several others, eventually localized. If this first sojourn constitute only a stage in the process of evolution, it is necessary that the primary host shall become the prey of a second; thus it is that, having gained the intestine, cystic worms become Tæniæ cercariæ Flukes, the future Trichinæ adult, the Linguatula of the Dog full grown, etc.

The transmission of parasites may also take place from an infected to a healthy animal, and it is in this way that scabies and phthiriasis are propagated by direct or mediate contact.

Lastly, in certain cases the instincts of the parasite count for nothing in its installation, as happens with the majority of those which live at liberty till they are of adult age. With these it is the female which is charged to deposit her eggs in the conditions required to insure the indispensable refuge, until the larval stage is reached. The Œstridæ furnish a well-known example.

The circumstances that surround the propagation of parasites are so varied, that they cannot all be passed in review here, but will find their place in the following chapters. In general, parasites are singularly favoured by their prodigious fecundity, and the great vital resistance with which a large number of them are endowed. Leuwenhoeck calculated that the female Louse may become in eight weeks the grandmother of 5,000 lice; according to others, the second generation of a single individual may furnish 2,500 progeny, and the third 125,000. Gerlach asserted that a couple of the Sarcoptes of Man might yield six generations in three months, the last generation comprising 1,500,000 individuals. The female Chigoe, when completely developed, is scarcely more than a bladder full of eggs. In a female Ascaris, the oviduct occupies nearly the whole of the body. Each mature segment of a Tænia is gorged with ova, and it has been computed that the *Tænia saginata* of Man may throw off in a year, by the successive detachment of its rings, as many as 150 millions of eggs. These startling examples would give cause for great alarm, did we not know how numerous, varied, and powerful are the causes which hinder rapid increase of these vermin.

But independently of their prolific capacity, many parasites possess an altogether remarkable vital resistance. The Ixodidæ can endure a very prolonged abstinence. Railliet has kept the *Argas reflexus* alive for fourteen months in a glass bottle, and Laboulbène has seen the *Argas persicus* remain active during four to five years, without receiving the least nourishment. There are Nematodes which complete desiccation only renders torpid, and which regain their activity under the influence of moisture. The muscle

Trichina can withstand cold of 15° (Cent.). Other Worms continue to exist in the midst of putrefying substances, and the ova and embryos of a large number of species are endowed with the same powers of resistance.

The propagation of parasites is facilitated by certain predisposing conditions. The zoological *species* of the host plays an important part. As has been said, few parasites are common to several species. There are, nevertheless, some which are more or less cosmopolitan in this respect; such is the Cysticercus of the pig-measle, the hepatic Fluke, the Trichina, and the larva of Linguatula tænioïdes.

Age has a manifest influence. Young animals are often invaded by Entozoa, and readily so by those which have to immigrate in the tissues, which are more delicate and offer less resistance. Old animals are also the favourite hosts of parasites, internal or external; they are less able to defend themselves from attack, and the contractions and secretions of the digestive organs are less capable of eliminating these vermin.

After these observations it will be understood that the *constitution* of the host plays an analogous part, and that weakly subjects are more liable to parasitism than those in the opposite condition. But this is not due to a verminous diathesis, as was at one time believed, but very probably to defective reaction. This explains the fact given by Delafond, that the Psoroptes deposited on the skin of Sheep in good condition did not multiply, and soon perished, while in debilitated sheep they rapidly increased.

The *state of the surroundings* in which the domestic animals are placed, may favour or hinder the multiplication of parasites. Those whose skin receives but little attention are liable to phthiriases and acariases, which are seldom seen in well-kept animals; and those which are clipped have more chance of escaping them. Crowding and dirty habitations aid in the propagation of parasites. The Herbivora, which live at pasture, alone harbour the larvæ of the Œstridæ; butchers' dogs and those of shepherds, are the favourite hosts of certain Tæniæ, whose cystic life is passed in the tissues of Herbivora; and there are also dogs which harbour parasites (*Linguatula*) in their nasal cavities, the larvæ of these parasites offering analogous facts. Flocks kept in dry pastures are exempt from distomiasis, and other examples might easily be given.

The influence of *Seasons* is related to the preceding. In summer are seen the adult Diptera, which torment animals by living on their juices, or by depositing larvæ in the skin; in summer, also, Ixodinæ appear, and Fleas breed; and we have the *Leptus* in autumn and the Lice in winter. Many of the parasitic diseases—as Scabies—undergo very remarkable seasonable variations. It is in the autumn that Sheep gather the germs of distomiasis, etc.

Countries operate according to their climate, and also by the management and the kind of feeding the animals receive in them. Many Ixodinæ and Argasinæ are peculiar to certain hot countries; the *Bilharzia crassa* has only been found in Egypt; the Gastro-

discus in Egypt, Guadeloupe, and Senegal. The Tæniæ of the Horse are frequent in Germany, but rare in France. In Iceland, Tænia echinococcus is found in one-third of the Dogs, and the Cystic form in the majority of the Sheep and Cattle. *Trichina spiralis* is particularly common in Germany and the United States. On the other hand, there are parasites which are found everywhere—such are the majority of the Tæniæ of the Dog, the Ascarides of the Horse, and the Cysticercus of the Pig.

Symptoms and Lesions.—The influence of parasites on the health of their host has been at all times the subject of contradictory opinions. Some authorities—as Andry, Nylander, Leuwenhoeck, etc.—have attributed to imaginary worms or inoffensive parasites the most diverse diseases, and chiefly epizoötic or enzoötic affections. Later, there was a tendency to consider the majority of the parasites as indifferent to their host, and even favourable to health. So it was that Abildgaard and Goeze admitted that Lice are the natural emunctories, and remove the bad humours secreted by the skin, while the intestinal Helminthes stimulate digestion, and consume the superfluous juices in the viscera. Bracy Clarke expressed a similar opinion with regard to the larvæ of Gastrophilus found in the stomach of the Horse; even in our own times, the Abyssinians consider that harbouring one or more Tæniæ is a sign of good health, and there are physicians to be found—though they are rare—who entertain such a doctrine.

It is no doubt true that at the autopsies of animals which showed every sign of health, the intestines may contain a considerable quantity of Worms; this is often the case with the Horse (Ascarides), and with the Dog and Birds (Tæniæ). The larvæ of Gastrophilus may cover nearly all the mucous membrane of the left sac of the stomach of a horse which is otherwise healthy; an Ox may, without any apparent inconvenience, have all the upper part of its body studded with parasitic tumours (*Hypoderma*); but we cannot therefore conclude from such facts that these are of any benefit to the hosts infested by them. At most, we might admit the indifference of the latter, or, better, the production of a reaction by which there is compensation for the inconvenience of this invasion. For these parasites are nourished on the tissues of their host, or on the chymous matters in the digestive organs, and they more or less obstruct those passages the freedom of which is favourable to health. They often finish by being a source of trouble especially if they bring about disadvantageous modifications in the constitution, these becoming manifest as parasitic diseases. The instances are numerous in which the tolerance of the organism is rapidly exceeded, either by the nature of the weapons of the parasite, its mode of attack, its rapid increase, or its habitat.

Sometimes—as with the majority of the intermittent or remittent parasites—the damage is not so much owing to the blood abstracted from the host, as to the torture the bites or stings produce; and at

other times—as with the psoric Acari—their breeding brings about in the skin disorders of nutrition, which have a bad effect on the general health; while certain of them which invade the ear, give rise to serious nervous disturbance.

In general, the intestinal parasites act by crowding, so as to cause mechanical obstruction, and digestion may become impaired; though rarely, in consequence of some defect in local resistance, there may be perforation or rupture of the organ. Sometimes the injury is limited to the abstraction of a certain quantity of blood, which the worm sucks from the mucous membrane (Ex.: *Anchylostomum*).

When the liver is very much infested icterus and anæmia occur as well as the symptoms and lesions of hepatitis. The respiratory organs, and especially the bronchi and lungs, with difficulty support the presence of parasites. Verminous bronchitis and pneumonia owe their gravity to the unceasing and increasing effects of a cause always acting more and more energetically. The parasites of the blood-circulation may not, for a long time, attract attention; but when they manifest their presence, it is by alarming symptoms resulting from alterations in the walls of the vessels.

The natural susceptibility of the nerve-centres scarcely permits them to withstand the presence of parasites. As the bony covering of these centres fits closely upon them, a parasite that penetrates it can only develop by causing compression and atrophy, which are nearly always fatal. In the same way the organs of vision betray, by disturbance of function, the invasion they have undergone.

The muscles are, of all the organs, the most tolerant. Pig-measles, trichinosis, etc., most frequently occur without arousing suspicion; the histological alteration the muscular tissue undergoes is not betrayed by marked signs.

Of the genito-urinary organs, the kidneys almost alone exhibit susceptibility, particularly in the case of Eustrongylosis; this susceptibility being accounted for by the enormous volume of the parasite.

Otherwise, it is evident that, independently of habitat, the pathological phenomena due to parasitism are subordinate to the number, dimensions, and mode of life of the parasites.

If they are in small number, they are only obnoxious when a delicate organ is attacked—as is witnessed in 'Gid,' or in verminous ophthalmia; or if their volume causes a great destruction of tissue (Giant Strongyle). It is usually by their accumulation that parasites become dangerous.

Many parasites of the stomach and intestine are nourished by the more or less modified alimentary matters contained in these organs. All the others derive their sustenance from the substance of their host. Some feed on the epidermic cells, or the débris of worn-out feathers or hairs; they might, therefore, be considered as mere mutualists, relieving the skin of useless materials, if we did not know that they may become exceedingly troublesome to their

host by causing atrophy of the papillæ, shedding of the feathers, and sometimes a real dermatosis.

The parasites which live on the blood are, from this fact, rarely dangerous to their host. Some—such as Fleas, Gnats, and other Diptera—puncture the skin, and leave it when their appetite is satisfied; others plunge into the fluid upon which they subsist (Hæmatozoa); and certain others, as the Hæmopis, may, nevertheless, extract such a large quantity of blood that anæmia results—a circumstance which is also remarked when the *Anchylostomidæ* are in considerable number in the intestine.

The majority of the parasites derive from the morbid products, the secretion of which they provoke, the materials for their development and maintenance. Those which are provided with a digestive apparatus ingest these materials; while others imbibe them by cutaneous osmosis. Among the Worms, the Nematodes and Trematodes are in the first category, and the Cestodes are in the second. This spoliation, aiding the compression, may induce atrophy of organs.

The anatomical situation occupied by the parasite in the tissues of organs is subordinate to its size. The smallest may be lodged in the elements of the tissues: the *Coccidium oviforme* in the epithelial cells of the Rabbit's biliary ducts; the Sarcosporidia, as well as the Trichinæ, in the ultimate fibres of the muscles; and the ova of *Strongylus vasorum* in giant cells. Others are contained in the natural cavities of organs: example, the majority of the parasites in the digestive canal. Some are found in cysts formed at the expense of the tissues of the host—such are the cystic or bladder-worms, Cysticercus, Cœnurus, Echinococcus, and also the Trichina. Or they may be lodged in real unilocular or multilocular abscesses—as the larvæ of the Hypoderma and the Spiroptera of the stomach; or in fibrous tumours, as *Spiroptera reticulata*; or in aneurisms, as *Sclerostomum equinum*. Lastly, the Worm is in direct contact with the tissues it has invaded, and excavated to effect a lodgment (Ex.: *Giant Strongyle, Filaria papillosa*).

Diagnosis.—The diagnosis of parasitic diseases rests principally on investigation and the determination of the parasites which cause them. There are many which do not give rise to any precise sign or symptom, and their presence can only be ascertained by an autopsy; often, even the name of the malady cannot be justly applied.

Sometimes the ejection of some parasites is the only symptom, and this frequently happens in cases of intestinal helminthiasis, especially in the Dog, and also for the gastric larval Œstridæ. When suspicion alone exists, certainty can only be ensured by a microscopical examination of the matters discharged, or of the excrements; in default of a parasite, ova or embryos may be found—as in distomiasis, and in verminous bronchitis and pneumonia; or, by a kind of partial *ante-mortem* autopsy, fragments of tissue

may be extracted from the animal, and their examination will remove all uncertainty—as by using the harpoon in trichinosis, or in the ablation of tumours due to the *Spiroptera reticulata*.

The symptoms proper, due to functional disturbance in the host, may also be sufficiently significant to permit a true diagnosis being established, and this will be confirmed at a later period—during the life or after the death of the patient—by the discovery of the parasite; this is usually the case in scabies, hypodermosis, distomiasis, verminous bronchitis, 'gid,' etc.

A somewhat frequent cause of error occurs in considering as parasitic the affections that coincide with the presence of minute organisms—animal or vegetable—which have absolutely no pathogenic influence. There are often found on the skin Cryptogamic germs, which are brought there with the dust from forage, or stray Acarina or small insects also derived from forage, litter, or grooming utensils; larvæ and various foreign bodies have also sometimes been mistaken for parasites, and in the intestine of Carnivora Helminthes, belonging to a lately eaten host, may be found that have resisted the digestive fluids. These are so many examples of what are termed *pseudo-parasites*.

Nomenclature of Parasitic Diseases.—The maladies caused by parasites have received various appellations, according to the state of science at the time they were so named. When their nature was not known, the names given to them were based on some important symptom—such are the terms *scab* or *mange*, *ringworm*, *favus*, *rot*, *measles*, *gid*, *hoose*, etc. Later, more precise terms indicate the progress made in knowledge; thus we distinguish in the mange or scab of the domestic animals sarcoptic, psoroptic, and chorioptic scabies, and in verminous bronchitis, verminous pneumonia, and verminous ophthalmia, affections characterized according to their seat, and, with varying precision, their cause.

At present the general tendency is to designate each parasitic disease by a word, the radicle of which is derived from the generic name of the parasite, this radicle being followed by the suffix *asis* or *osis*. Examples: *Distomiasis*, *Phthiriasis*, *Acariasis*, *Helminthiasis*, *Trichophytosis*, *Filariasis*, *Strongylosis*, *Trichinosis*. Parasitic diseases having always an immediate and known etiology, residing in the parasites producing them, this division of pathology has thus the advantage of possessing a rational nomenclature.

Prognosis.—The gravity of the disturbances due to parasites is subordinate to the alterations they determine. Inappreciable with some parasites, the symptoms exhibited may appear in every degree —from that of mere inconvenience to the extent of deadly disease— a fatal result ensuing more or less rapidly, according to the organ attacked.

The seriousness of many parasitic disorders depends upon their often appearing in an epizoötic form in the whole of a herd or flock,

over a wide district, or throughout an entire country. This may depend upon whether the majority of the animals have been submitted to conditions which permit the invasion of the parasites—distomiasis, for instance; or whether their agglomeration has extended the contagion—as in scabies. There is multiplication of the losses by death, by depreciation of the flesh, wool, or skins, by the difficulty in fattening, by the incapacity of working-animals, and by the time required and expense incurred in attending to them.

On other occasions, a disease which may be benign in one animal may acquire an extremely serious character if due to certain heteroxenous parasites, which become dangerous in their second form. The helminthiasis of the Dog, insignificant in itself, is of much gravity for numbers of the Herbivora, in which—according to their species and the kind of Tænia—it may be the source of 'gid,' echinococcosis, or several cysticercoses.

But that which gives this study much of its interest, is the fact that the danger from these heteroxenous parasites is often threatened to Man. Without considering scabies and ringworm, which he may derive from contact with animals, he may find in what he eats the germs of trichinosis, and those of the armed and unarmed Tæniæ; while the Dog may also transmit to him the Echinococci.

Prophylaxis.—If we do not yet know the precise mode of introduction of a great number of parasites, we are yet not altogether at the mercy of their invasion. For them as for the others, their germs are certainly derived from without; and it is evident that our animals can be rendered absolutely safe from them, if we can insure the rigorous cleanliness of the various hygienic agencies—the air, water, food, harness, etc. It is on this point that attention should be fixed at first; but as it requires continual, fastidious, and patient care, it is generally neglected in practice, and only comes into notice when circumstances have demonstrated the existence or imminence of an invasion. This is a consequence of the exigencies of rearing animals.

In dealing with ectoparasites, the animals attacked should be isolated, and the place they occupied—and, by preference, the whole premises—scrupulously disinfected. In this respect, boiling water is the best agent.

For the endoparasites, the preservative measures should be subordinate to what is known of their mode of introduction. Water having in this instance the greatest share, its purity should be attended to. Abstention from such watering-places as ponds, pools, streams, cisterns, etc., into which rain-water passes, is necessary, if these receive and retain various dejections containing germs of parasites. In taking precautions against some heteroxenous parasite, we should keep away the definitive host; for instance, we ought not to allow Dogs to eat the heads of Sheep which have died of 'gid'; flocks of Sheep should be kept from Dogs which have Tapeworms; Sheep should not be allowed to graze on damp pastures,

where they may find Snails infested with the Cercariæ of Distomata, etc. But for each malady to be hereafter studied, more precise information will be given on these various points.

All the parasites met with—those ejected by the natural passages, or collected by grooming tools—and all the organs which, after examination, are found to be infested, should be carefully destroyed by fire or by boiling. Above all, they ought not to be thrown on dungheaps, where rain may carry the germs they contain into drinking water. At most, Dogs should only be permitted to consume parasitic viscera when it is ascertained that infection cannot be transmitted by these animals. Boiling, of course, renders the viscera safe as food.

Treatment.—In the therapeutics of the parasitic maladies, it is sometimes advantageous to improve the general health by tonics and alteratives. Nevertheless, a definite result cannot be obtained if the efforts have not for their principal, and most often exclusive, object the destruction of animal or vegetable organisms which, inhabiting some part of the body, live at its expense. The name *parasiticides* (*parasitus*, parasite ; *cædere*, to kill) is given to agents which possess that property. They are naturally divided into two groups : the *ectoparasiticides*, which destroy external animal or vegetable parasites ; and the *endoparasiticides*, or *anthelmintics*, employed against helminthes or entozoa, which live in the interior of the body of man or animals.

These medicaments are extremely varied. There are some, as fatty substances, which, by closing the respiratory stigmata of the Epizoa, asphyxiate them ; but nearly all act as poisons on the parasites against which they are directed, and a certain number being irritants also for the host, require the observance of certain precautions in their employment.

Parasites situated in the tissues, or in cavities not in communication with the exterior, cannot be reached directly by medicaments, and we do not know of any substances which can be administered without danger, in sufficiently large quantity to be distributed throughout the organism by diffusion or the circulation.

Nevertheless, these inaccessible parasitic diseases have not necessarily a fatal issue. In general, the deep-seated parasites cannot reproduce, and their number is therefore limited to those which formed the first invasion. If this is not mortal, then time diminishes the vitality of the parasite : its volume becomes reduced ; it undergoes calcification, and is then only a foreign body, inoffensive because of its small dimensions.

In some instances surgery extends the resources of antiparasitic therapeutics. It is by hydrotherapy and trephining that we combat the Cœnurus cerebralis, by the extirpation of tumours the Spiroptera reticulata, by injections or fumigations the Linguatula of the Dog and the larvæ of the Sheep Œstrus, and by puncture those of the Hypoderma of the Ox.

Lastly, there are parasitic affections which disappear of themselves, by virtue of the laws which control the evolution of parasites. Such are those which are allied with the seasons.

In the following chapters, to facilitate study, the parasites will be examined as to their pathological influence according to their habitat, and the treatment appropriate to each particular case will be indicated.

BOOK I

PARASITES OF THE SKIN

By its peripheral situation and its relations with the external world, the skin is, more than any other apparatus, exposed to the invasion of animal or vegetable parasites. These arrive directly at its surface, fix themselves there, and are propagated readily from the affected to the healthy animal. The maladies they occasion vary in seriousness, according to the mode of parasitism they affect — their habits, requirements, and their habitat superficial or profound. In general, the diagnosis of these affections is easy, the determination of the cause being within the immediate reach of the observer; and so, for the same reason, is the treatment. Some of these diseases disappear spontaneously, as a consequence of the conditions which preside over their development—tumours (Hypoderma), and stings (Diptera). Nevertheless, the majority have a tendency to perpetuate themselves and become aggravated, by direct reason of the fecundity of the parasites, and—owing to the absence of appropriate treatment—the grave disturbance in the functions of the skin bringing about loss of condition in the individual.

There is a small number of parasitic dermatoses which are markedly distinguished from the others in every respect. They are due to some Nematode which leaves the interior of the body and is attracted to the skin by accidental or instinctive selection. The diagnosis is easy, but not so the treatment which—not being capable of reaching the parasite at its source—has no influence on the progress of the malady, otherwise in itself of little gravity.

The parasitic dermatoses naturally divide themselves into ***dermatozoonoses*** and ***dermatomycoses***, according as the parasites are animal or vegetable. The latter are few, and form quite a distinct group, as much by their physiognomy as by their nature. The dermatozoonoses, on the contrary, are extremely varied, according to the host affected, and especially owing to the numerous species of parasites which may produce them. The majority belong to the class of insects and to that of Arachnida; some are Nematodes.

All the parasitic insects belong to the order ***Diptera***, or that of the ***Hemiptera***.

The *Diptera* are suctorial Insects, provided with only two wings, and undergoing complete metamorphoses. The two existing wings are the anterior ones; they are nude and membraneous. The posterior wings are replaced by two *balancers*—small organs, each composed of a slender stalk terminated by a round knob, and furnished at its base with a small scale, concave below, convex above—the *spoon* or *tegula*. The buccal apparatus is a proboscis or sucker, adapted for the suction of fluids, and frequently for puncturing: the lower lip, in effect, is transformed into a canal, and the other pieces into setiform stylets, six at most, lodged in a canal. To the mouth are annexed salivary glands, the secretion of which is often poisonous, and causes irritation consecutive to the puncture. By the fact of their complete metamorphoses, on their issue from the egg the Diptera are in the form of apodal larvæ; then they become pupæ or nymphæ, and finally acquire the perfect state. They are divided into three sub-orders: *Nemocera*, *Brachycera*, and *Aphaniptera*. The latter is constituted by the *Fleas*, which, by reason of their mode of existence, are distinct from the Diptera—properly so called—from a parasitical point of view.

The *Hemiptera* are also suctorial Insects, generally provided with two pairs of wings, the anterior of which are of variable consistence, while the posterior are membraneous; their metamorphoses are null or incomplete. They are likewise divided into three sub-orders: *Homoptera*, *Heteroptera*, and *Aptera*. The latter is essentially parasitic, and composed of insects which will be studied under the name of *Lice*. Of the two other sub-orders, Heteroptera is alone referred to, as it contains the Bugs, the noxious action of which will be considered after that of the Lice.

The parasitic Arachnida of the skin all belong to the order of *Acarina*, the study of which will form a special chapter.

The various parasites of the skin contract with their host relations more or less intimate, more or less continuous, and more or less necessary, which are in this respect subordinate to the state of perfection of their organization. Some—such as the Simulium and the Breeze, Ox, and Horse Flies—only come into contact with the domesticated animals at long intervals, in order to puncture them and suck their blood. Others—like the Hippoboscidæ—are independent, and live for a long time in contact with the Horse's skin. Others, again, which are agile, but have no wings, only exceptionally live—and then only for a very short time—away from their natural host: such are the *Epizoa*—Fleas and Lice. Those which live deeper in the skin—the *Dermatozoa*—comprise the Acari of scabies, lodged in the epidermis; the Demodex, not so well endowed, sheltered in the hair follicles and sebaceous glands; the larvæ of the Hypoderma, which penetrate beneath the skin itself; the Nematodes, which are met with in the substance of the derma, and in the products the formation of which they have excited. This sketch will show the intimate relation that usually exists between the organization of the parasite and its localization, more or less deep and permanent, in the skin of its host.

The disturbances generally due to parasites are of an inflammatory character—hyperæmia, exudation, pustules, efflorescences, crusts, hæmorrhage, abscesses, nodules, etc. They are due to the presence of the parasites only, or to their migrations or punctures.

These organisms act also in causing pruritus, which impels the infested animal to scratch itself; whence arise secondary alterations of variable intensity—such as erythema, depilations, excoriations, pustules, and ulcerations.

The symptoms of parasitic dermatoses consist of the above pathological processes, and especially in the presence of the parasites, their zoological characters, and their mode of existence. The gravity of the symptoms is subordinate to the facility with which medicinal agents may reach the parasites. But that which is most deserving of attention is the contagion, which is sometimes exercised with provoking facility, and outstrips by its rapidity all endeavours made to localize the disorder. Finally, when parasitic dermatoses prevail among animals in feeble health or badly attended to, they may bring about general troubles, and a physiological misery which is sometimes fatal.

In the following description, the parasites of the skin will be examined as closely as possible in their zoological order, subordinating this in part to the seat of the maladies and to their gravity. This will embrace successively:

1. The study of the parasitic Diptera in the state of perfect Insect or *imago*;
2. That of the larvæ of the Muscidæ and Œstridæ;
3. That of the Fleas;
4. That of the Lice (*phthiriases*);
5. That of the Acarina (*acariases*);
6. That of the cutaneous Nematodes (*cutaneous helminthiases*);
7. That of the Dermatophytes (*dermatomycoses, trichophytoses, favus*).

CHAPTER I

DIPTEROUS PARASITES IN THE PERFECT INSECT STATE

THESE are free and intermittent parasites, for they only visit animals at more or less long intervals, in order to prick them and suck their blood, or merely to feed on their perspiration. They are commonly called *Flies*, although only a very small number belong to the same family as the Flies, properly so called. They are comprised in the two sub-orders of *Nemocera* and *Brachycera*, thus named because of the form of their antennæ.

The antennæ of the *Nemocera* (νῆμα, thread; κέρας, antenna) are filiform—sometimes plumose in the males—and formed of at least six articles or pieces, In the *Brachycera* (βραχύς, short; κέρας, antenna) they are short, and composed of only three articles, the last of which, stronger and often segmented, usually carries a fine stylet.

Nemocera.—In this sub-order, which has fewer genera than the other, the *Culicidæ* (Gnats) and *Simuliidæ* only come within our study. Both pass their larval phase in water, in damp ground, or in shady places. It is in the latter also that they abound in the adult state, although winds may carry them far from their place of origin. They subsist on vegetable juices, but the females often attack animals, to prick them and suck their blood. The speckled-wing mosquito (*Anopheles claviger*) has been shown to be capable of harbouring the protozoon of malaria after being fed with malarial blood, and the anopheles so infested has been proved, by direct experiment, to be capable of giving the disease to the human being (Sidney Martin).

The **Gnats** (*Culex* Linnæus) form the type of the family of Culicidæ. They are recognised by their long body, their antennæ composed of fourteen articles, which are filiform and very plumose, especially in the males; by their bulging prothorax, narrow, cylindrical abdomen, their long thin legs, elongated narrow wings lying flat on the body during rest, and their humming during flight. The proboscis comprises six bristles or setæ, and carries laterally the two maxillary palps, longer than the proboscis in the males, and very short in the females.

The best known species is the **Common Gnat** (*Culex pipiens* L.).

It is 5 to 6 millimetres long, thorax brownish-yellow, with two dark lines on the dorsal surface, the abdomen pale grey, with ash-coloured rings (or segments); the legs are elongated and brown. It is found everywhere, and abounds particularly in the neighbourhood of damp places and stagnant water, which are necessary for the opportune laying of its eggs and its metamorphoses.

It torments Man, particularly during the night, and in some countries constitutes a veritable scourge. Its sting, due to the penetration of the stylets of its rostrum into the skin, is not perceived at first, but it soon becomes the seat of intense itching and slight swelling, without doubt owing to the poisonous saliva the insect ejects.

To the genus Culex belong the Mosquitoes of America, the West Indies, Mexico, and South America, where they are, for mankind, a source of incessant torment. Certain travellers even affirm that they are obnoxious to the multiplication of Cattle in the llanos or prairies of Venezuela, persecuting them to such a degree as to prevent their thriving on the richest pastures.

It is not very probable that, in our country, the Gnats attack animals; in any case, they are far from being as aggressive and tormenting as with Man. Cobbold, however, mentions a *Culex equinus* which more particularly attacks Horses.

The scourge which takes the place of the Gnats with regard to the domesticated animals, though not sparing Man, is found in the genus *Simulium*.

The **Simulium** (*Simulium* Latreille), typical of the family of Simuliidæ of Schiner, has a thick body, bulging thorax, somewhat short, cylindrical antennæ formed of eleven articles, the two first being separated from the others; the abdomen is relatively short and broad; the legs are strong, with wide tarsi; the wings are very broad, short, and lying flat. The proboscis only comprises two resisting bristles designed to puncture, and is provided on its sides with two maxillary palps having four articles, the last of which is long and slender. These Insects do not hum when flying. They are invested in a fine downy covering; the males, much fewer than the females, are darker and more velvety, have the wings variegated, and the legs broader and more hairy.

The Simulium usually keeps to watering-places, shaded by trees, and flies in swarms towards sunset. The family subsist on the juices of vegetables, but the females often attack animals and Man, sucking their blood with avidity, and producing painful stings. They are encountered in all climates.

FIG. 1.*—*Simulium reptans.* — After Woodward.

In Lapland, they are sometimes extremely abundant in May and July, and by night and day prey upon Man. According to Guillard, 'it is not rare to see Calves and Sheep succumb to their bites. The Reindeer only escape the torture by taking refuge beside glaciers and on the summit of mountains.' The Lapps preserve themselves and their Reindeer from these pests by living in the smoke of large fires. The principal species are *S. boreale*, *S. reptans* (Fig. 1), *S. cinereum*, *S. molestum*, *S. pecuarium*, *S. meridionale*, etc.

Various parts of the New World are often infested with them. In Brazil and South America they are known as *Musquitoes*; in North America they are called *Black Flies* and *Brûlots*.

* The line to the right of this and other figures indicates the natural length of the creature represented.

Like that of the Gnats, the puncture of the Simulium is followed by a somewhat smart local irritation, probably due to the venomous saliva shed therein. These Insects have been accused of propagating anthracoid or septic diseases, it being supposed that, after having sucked the blood of an animal attacked with one of these affections, their proboscis, charged with this virulent fluid, may inoculate any healthy animal which they chance to fasten upon.

The Simuliidæ of Europe, though only numbering a few species, are, according to Laboulbène, somewhat difficult to distinguish from one another.

The commonest appears to be **Simulium reptans** (Fig. 1). 'The male is dark and velvety, with the margins of the thorax greyish; the female grey. The legs have white rings; the base of the wings and the balancers are yellow. Length, 2 to 3 millimetres' (Laboulbène). It is somewhat common in the Paris basin.

Spinola mentions that certain Diptera in Brandenburg, which he identified as *Simulium reptans*, and that, again, as the *S. Columbatczense*, attack Horses at pasture, and prick their ears more especially. Where these punctures have been made there appear white spots, which render the skin as if fly-bitten.

The **Grey Simulium** (*S. cinereum* Mac.) is of a dark-grey tint, with the antennæ black, the thorax marked by three black, rather indistinct, longitudinal lines, and the abdomen by three black transverse lines. Legs black. Length, 3 to 3·5 mm.

Mégnin has made similar remarks on this species to those of Spinola on the *S. reptans*. According to him, it is common more especially in the large forests in the centre and north-east of France. It chiefly attacks Horses on those parts where the skin is fine and destitute of hair, as on the inner surface of the thighs, and the interior of the auricular concha. The punctures—which are usually very numerous on a small space—give rise to a somewhat severe inflammation, the subsidence of which is accompanied by an abundant epidermic exfoliation and shedding of the hair. Some Horses, for several days after these attacks, have their ears so sensitive that it is difficult to bridle them. In others of good breeding and nervous temperament, the pricks of the Simulium inside the ears have been followed ' by a veritable *psoriasis guttata*, characterized by small lenticular patches, isolated or confluent, covered by a white, nacrous, epidermic stratification, beneath which the integument has disappeared, as in vitiligo.' Fleming states that he found this insect in England during the Cannock Chase manœuvres in Staffordshire, in 1872. The horses of the Royal Engineers were picketed in a narrow valley near the river Soar, where they were greatly annoyed by myriads of this Simulium, which congregated inside the ears, and gorged themselves with blood. Subsequently, the white patches mentioned by Spinola and Mégnin appeared on the skin lining the ears.

Another species, the multiplication of which is sometimes very troublesome, is the **Spotted Simulium** (*S. maculatum* Meig.).

The male is of a velvety black, with the sides of the thorax in front of a silky yellow, and the base of the abdomen also yellow on each side. The female

is bluish-grey, with three black longitudinal bands on the thorax. The abdomen has three black contiguous spots above. Length, 2 to 2·5 mm.

The spotted Simulium is abundant in summer in woody and marshy places, and often attacks animals, particularly in warm and stormy weather. In April, 1863, the canton of Condrieu (Rhône) was particularly troubled, in consequence of the extraordinary multiplication of these flies. Professor Tisserant, of the Lyons Veterinary School, observed that they chiefly attacked Horses and Cattle, annoying Sheep and Goats less, and not even sparing Man. They sought those parts of the body where the skin was thinnest and had least hair. When the Insects were numerous these parts became red, even bleeding, and denuded; then followed a hard and painful tumefaction, with fever, and sometimes symptoms of dyspnœa and intoxication, which might result in death in from twelve to fourteen hours after the invasion of these swarms of Simulium. In fact, eight or ten cattle did die. 'For some time,' Railliet justly remarks, 'it was sought to attribute these accidents to an epizoöty of anthrax, in which the insects acted only as carriers of the virus. But this was an entirely gratuitous supposition.' Conviction as to the fact of these Insects being the cause followed the study of the event, and especially when it was remembered that a similar, if not identical, species gave rise to serious consequences in certain parts of Central Europe, where it is famous as the *Kolumbatz Fly*.

The Simulium of Kolumbatz (*S. Columbaczense* Schiner), female—the male is very rare—measures 3·37 mm. to about 4 mm. It is black, entirely covered with a whitish dust and yellowish hairs; the antennæ are yellow; the legs are white in the living specimen, but become yellow after death; the wings are hyaline.

This species derives its name from an old castle in Servia—district of Posharavatz—on the right bank of the Danube, where it abounds in low-lying, damp, and woody situations in that neighbourhood. It was there that its damaging effects were first observed and decribed by Schönbauer. It was subsequently found here and there throughout nearly the whole of Germany; but it is only abundant in Southern Hungary, Servia, Austria, and Moravia, and is most numerous after inundations from the Danube. Damp shady places are its favourite haunts, as it passes the first phases of its development in water. Near the castle of Kolumbatz are vast limestone quarries, where the Insects doubtless find shelter during unfavourable weather, and this may explain the tradition ascribing the abundance of these little Flies to this locality.

From the early days in May, they appear in such numbers that, from a distance, the swarms seem like dark clouds; it is impossible to breathe without getting them into one's mouth, and white animals upon which they settle appear quite black. They alight upon Man, but prefer the domesticated animals, which they chiefly attack around the natural openings, penetrating even into the air-passages. 'Each puncture this Insect makes,' says Schönbauer, 'causes a burning itching, and a very hard and painful tumefaction which rapidly forms, and does not disappear until after eight or ten days. When the punctures are numerous and close to each other, they occasion a violent fever, and, in irritable individuals, cramps and convulsions. It will be understood, after this, how these small Insects can kill large animals in a few hours, when they inflict at one time thousands of punctures on the most sensitive and thinnest parts of the skin, and when from these punctures arise

thousands of small, very painful swellings, which merge into a large tumour, and develop a violent inflammation. . . . The animals succumb to the inflammatory fever and asphyxia, the Insects filling and obstructing the larynx, trachea, and bronchi. Some of the animals even succumb during the course of the invasion of the Simuliidæ, others a few hours afterwards, and others, again, during the following night. The finer the skin is the more the punctured part is sensitive, the consecutive irritation is much more intense, the swelling greater, and the consequences more serious. This is why women, children, and young animals suffer much more from the punctures than men and aged animals. There are instances recorded of children being killed by these Insects—these occurrences taking place more especially when the mothers, occupied in the fields, have left their progeny lying on the ground.'

According to Tömösváry, death is due to the multitude of punctures, to the pain they cause, the small hæmorrhages, and the poisoning of the blood by which they are followed. The female Insect is alone capable of pricking, and it acts with such vigour that it buries its entire head in the skin, and, having gorged itself, falls helpless to the ground.

In 1783, in the neighbourhood of Kolumbatz, the losses due to these Simuliidæ were not less than 52 Horses, 131 Cattle, 316 Sheep, and about 100 Pigs. In 1813 and in 1830 in this locality many hundreds of Horses, Cattle, and Sheep perished from this cause. In 1878 several localities of Central and Southern Hungary were severely visited by these pests, and in certain parts from 20 to 30 cattle died daily; the herds were so plagued that they could only be sent to graze at night.

Brachycera.—This sub-order, which is very extensive, has been divided into a great number of families; but the only species which belong to the subject of this chapter are those of the *Tabanidæ*, *Asilidæ*, *Muscidæ*, and the *Hippoboscidæ* or *Pupipara*.

The **Tabanidæ** have a broad and slightly flattened body, the wings often apart, the head large and depressed from before to behind; the eyes are contiguous in the males; the last article of the antennæ is annulated, but has no stylet; the proboscis, usually salient, comprises six stylets in the female, four in the male; the tarsi are furnished with three cushions. The proboscis is exserted, enclosing lancets and ending in two fleshy lobes; their wings are extended horizontally, are moved by powerful muscles, and provided with a great number of nervures.

These Insects, and particularly the Breeze-flies, 'are,' says Macquart, 'spread over the world; each climate has its own proper species; and with regard to instinct, it is everywhere the same. The Lion in the deserts of the torrid zone and the Reindeer of Lapland have them for enemies, as have our Oxen and Horses. At the moment when the Insect fixes itself, the proboscis pierces the thickest skin, and blood flows immediately. The females alone attack, the males living on the sap of flowers, though the former have also been found on them; it even appears that the Pangonia have no other food. The Tabanidæ more particularly frequent woods and pastures; and it is during summer, and the warmest hours of the day, that they are most redoubtable. Their flight is rapid, and accompanied by a buzzing sound.' This revealing noise is for the threatened animal a cause of alarm; but it is in vain that, by movements of limbs or tail, it can repel the enemy, which suddenly descends on it, choosing the parts where the skin is finest, and burying therein the powerful sharp proboscis, which is not withdrawn until the creature is satiated with blood. And

after its departure there flows a last drop of blood; then appears a slight swelling, which generally disappears in a short time. The Breeze-flies usually only attack the larger domesticated animals—the Ox and Horse, and, in Algeria, the Camel. They may be agents for the transmission of virulent diseases, when they quit an animal affected with one of these maladies and introduce their soiled proboscis into the skin of a healthy one. In this way the *Tabanus tropicus* is said to convey the blood parasite (*Trypanosoma Evansi*) of Surra from infected to healthy animals.

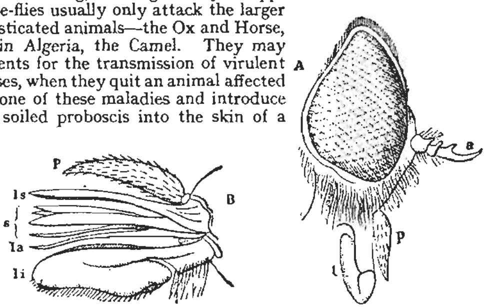

FIG. 2.—Autumn Breeze-fly, Female.—Delafond.

A, Large head, seen in profile: *a*, antennæ; *p*, maxillary palp; *t*, proboscis. —B, Details of the proboscis: *p*, palp; *ls*, epipharynx; *s*, mandibles and maxillæ; *la*, hypopharynx; *li*, inferior lip, forming the sheath of the proboscis.

The Tabanidæ comprise several hundred species. The most common among the indigenous species are the following:

The **Breeze-flies**, properly called, belong to the genus *Tabanus* (Linn.); they are characterized by a short, thick, slightly salient proboscis, and the last article of the antennæ is notched in crescent form.

The **Ox Breeze-fly** (*T. bovinus* Linn.), the largest of the indigenous species, measures 27 mm. in length. It is of a dark-brown colour; the thorax, covered with yellow hairs, is marked by black longitudinal bands; the abdominal rings are fawn-coloured at their posterior border, and on the middle of the dorsal face of each is a white triangular spot. By its strength and size, this very common species is most formidable. In Burgundy, it is known as the Great Breeze-fly (*gros Tavin*), to distinguish it from the others, which are merely named Breeze-flies (*Tavins*).

FIG. 3.—Autumnal Breeze-fly, natural size.—Railliet.

The **Black Breeze-fly** (*T. morio* Lat.), 18 mm. long, is of a shining black colour. It has fuliginous wings, and the third article of the antennæ is sickle-shaped.

The **Autumnal Breeze-fly** (*T. autumnalis* Linn.) is 18 to 20 mm. long, is dark-coloured, with the thorax grey and velvety, and marked by four brown longitudinal bands, three rows of white spots on the abdomen, the wings non-fuliginous, and the legs yellowish white, the extremity being black.

The **Noisy Breeze-fly** (*T. bromius* Linn.) is from 14 mm. to 16 mm. long, and differs from the preceding by its smaller size and more particularly by its brighter thorax, by three rows of yellow spots on the abdomen, and by its more hyaline wings.

The **Rustic Breeze-fly** (*T. rusticus* Fab.) has the same length as the preceding, but is of a dark-grey colour, has thick yellowish hairs, and is yellow or rust-tinted at several points.

The **Tawny Breeze-fly** (*T. fulvus* Meig.) is 16 mm. long, and is more tawny than the preceding, principally from the thick down covering it; it has, like the Ox Breeze-fly, only one line of white spots along the abdomen.

The **White-footed Breeze-fly** (*T. albipes* Fab.), from 23 mm. to 25 mm. long, is black, with yellowish hairs, and tufted on the thorax and two first rings of the abdomen; its legs are yellow.

All these species, which are the most important of the genus, have the same habits and same avidity, but they are not all equally common; the order in which they have been mentioned is that of their frequency.

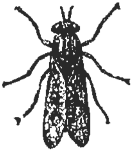

FIG. 4.—Small Rain Breeze-fly, magnified two diameters.—Railliet.

In North Africa, and especially in Egypt and Algeria, there is a widespread species, which appears to be the *Tabanus albifacies*, and which the Arabs—bedouins or fellahs—name *El Debab* or *Debane* (Fly). They wrongly blame it for a mortality that often occurs among their Horses and Camels in the marshy regions they frequent. Piot has shown that these losses are independent of the stings of this Insect, and should be attributed to other parasitic affections, and especially to a pernicious anæmia due to the presence of numerous hyatid cysts in the lungs.

The genus **Hematopota** (Meig.), which differs from that of the Breeze-flies more especially by the absence of the crescentic notch in the third article of the antennæ, and by the overlapping wings, has for its principal species the *Hematopota pluvialis* (L.), or small Rain Breeze-fly. This species is readily distinguished from the other Breeze-flies by its size (1 centimetre), its elongated and somewhat narrow abdomen, its very fuliginous wings marked by hyaline spots, its greenish eyes with reddish sinuous streaks, and the abdomen with a white middle dorsal line and a row of small white spots.

Very common in summer, the Hematopota pluvialis harasses animals more especially in stormy weather; Man is also liable to its attacks. It is said to be met with in Lapland, where the Reindeer suffer from its visitations.

The **Chrysops** (Meig.) is distinguished from the preceding genera by the presence of three accessory eyes or *ocelli*, which are very visible on the top of the head, and derives its name from its golden-green eyes, with purple lines and spots. The most interesting species is the **Blinding Chrysops**, or **Small Blinding Breeze-fly** (*C. cæcutiens* L.). This is an Insect 9 mm. long, with wings very wide apart, and the abdomen flattened and square-shaped almost to its extremity, is yellow at the base, and grey for the remainder of its extent; the wings are brown, with a large hyaline spot near the base, and another triangular one near the extremity.

Common in summer, the blinding Chrysops is so named because it prefers to puncture the larger domesticated animals around the eyes. It also attacks Man.

The genus **Pangonia** (*Latr.*), which belongs to the same family, only merits special mention here because Mégnin attaches to it some Dipterous females brought from New Caledonia, where, according to Germain, they attack the Cattle like the Tabanidæ, and thus concurred in the propagation of an epizoöty of anthrax that prevailed in Pine Island. Megnin, who describes them, names them *P. Neo-Caledonica*.

FIG. 5.—Small Blinding Breeze-fly, magnified two diameters.—Railliet.

The **Asilidæ** offer little interest. The **Asiles** (*Asilus* Linn.), which are specially destructive of Insects, have the reputation—perhaps badly founded—of being tormentors of animals, like the Breeze-flies. It is the **Hornet Asilus** (*A. crabroniformis* Linn.) which is particularly inculpated in these misdeeds. It is recognised among all the Diptera by the resemblance it has, at the first glance, to a Wasp. It is from 23 mm. to 27 mm. long; its thorax is brownish-yellow; the abdomen, narrow and elongated, is black in its three first rings, and bright yellow in the others; the feet are fawn-coloured, the wings dull yellow and spotted black at the inner border.

The family of **Muscidæ,** which includes all the Flies properly so called, is extremely rich in genera and species.

With these Insects, the antennæ—usually inflected in front of the head—have their last article enlarged in the form of a palette, and provided at its base with a bristle which is most frequently dorsal. The proboscis, inflected, is essentially formed by the lower lip, and generally terminates by a soft enlargement; it contains only two stylets. The tarsi are provided with two hooks and two cushions.

Allusion will be made here only to those Muscidæ which attack animals, in order to feed on their blood or cutaneous secretions. Hereafter, those will be described which are only parasitic in the larval state.

The first belong to the genera *Musca, Stomoxys, Hæmatobia, Aricia, Hydrophoria, Hydrotæa,* and *Glossina*:

The Flies (*Musca* Linn.) have the stylet of the antennæ plumose to the end, and a soft proboscis adapted for suction, but incapable of penetrating the skin; so that if these insects trouble Man and animals, it is only to imbibe their perspiration. They cause annoyance by their importunity, and irritate by the tickling and itching they induce by their pads and proboscis. They are found in our houses, in stables, cowsheds, sheep-folds, etc., and in paddocks and pastures. Of an ash-grey or greyish aspect, they resemble the **Common Fly** (*M. domestica* Linn.), so well known, and are distinguished from each other by such minute differences that there can be no practical interest in reproducing these; as all the species, beside their general likeness, have almost identical habits, and to an equal degree torment the domesticated animals during warm weather. Such are: the bovine Fly (*M. bovina* Robineau Desvoidy), the crow Fly (*M. corvina* Fab.), the cow Fly (*M. vaccina* Rob. D.), the vagabond Fly (*M. vagatoria* Rob. D.), the vitripene Fly (*M. vitripennis* Meig.), the executioner Fly (*M. carnifex* Rob. D.), the importunate Fly (*M. stimulans* Rob. D.), the garden Fly (*M. hortorum* Meig)., etc.

The **Stomoxes** (*Stomoxys* Geoff.), often called *Stinging Flies*, have a solid, elongated proboscis, bent near its base, horizontal, and extending beyond the head in front. This character serves to distinguish them immediately from the Flies, which they otherwise closely resemble.

A very common species is the **Stinging Stomoxys** or **Obstinate Stomoxys** (*S. calcitrans* Geoff.). It appears at the end of summer and commencement of autumn, and enters our houses, stables, and cowsheds. It attaches itself by preference to the legs of Horses, which causes them to stamp in order to get rid of it—hence the name *calcitrans* given to this species. With fine-skinned, sensitive

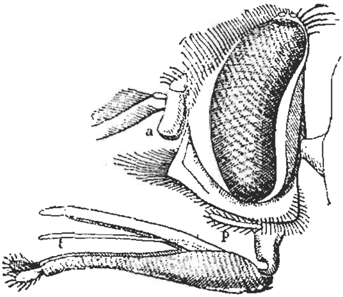

Fig. 6.—Head of the Stinging Stomoxys, highly magnified and seen in profile.—Delafond.
a, antennæ ; *p*, maxillary palp ; *t*, proboscis.

Fig. 7.—Stinging Stomoxys, natural size.—Railliet.

animals, the puncture of the Stomoxys may be followed by a large papule, on which the hairs are erect. Its larvæ live in the fresh dung of the Horse. When at rest, the Stomoxys and domestic Fly are distinguished from each other in that the first carries its head upward, while the second has it in the opposite position. It has been supposed that the Stomoxes may be agents in spreading anthracoid maladies, by stinging in succession a diseased and a healthy animal, but no proof of this has been given.

The **Hæmatobia** species (Rob. D.) also resemble the Flies, though they are smaller. They have a proboscis like that of the Stomoxes, and are particularly *distinguished for the length of their palps, which equals that of the proboscis* ; while in the Stomoxes the palps do not exceed the anterior border of the buccal fossette.

Thus, as their name indicates, the Hæmatobia species are no less greedy of blood than the Stomoxes, but they do not enter stables ; they only frequent pastures, where they are very troublesome to Horses and Cattle. Linnæus was of opinion that they were favourable to the health of these animals ; for in collecting in large numbers on their bodies, they compelled them to keep moving, and so prevented them from eating too much, which might be hurtful to them. The *Hæmatobia stimulans* (Meig.), *H. ferox* (Rob. D.),

H. irritans (Meig.), and *H. serrata* (Rob. D.), are the principal French species.

The Saw or Horn-fly (*H. serrata*), chiefly characterized by the shape of the posterior tarsi in the male, which have the form of a saw, belongs especially to Southern France. It appears to be widely distributed in the United States of America, into which it has been probably imported from Europe. Of late years, by reason of its multiplication, it has created much alarm by the way in which it has caused cattle to suffer, and so prevented their thriving. When these insects are in large numbers, they gather to rest at the base of the horns, which they cover for some inches. During heavy rain, they collect on the under side of the animal's abdomen. They attack, by preference, the back, flanks, and upper parts of the limbs. According to the investigations of Howard, the *H. serrata* deposits its eggs in fresh dung, where the larvæ are hatched in about twenty-four hours, and there they develop. Nymphosis takes place in the superficial layers of the soil covered by the dung. The perfect insect appears in about fifteen days after the egg has been laid. To prevent the multiplication of this species, it suffices to throw lime over the dung lying on the pastures.

The **Arices** (*Aricia* Macq.), the **Hydrophores** (*Hydrophoria* Macq.), the **Hydrotes** (*Hydrotæa* Rob. D.), possessing the same habits and causing the same discomforts as the Flies, are distinguished from the preceding genera by their balancers, which remain exposed; while in Flies, Stomoxes, and Hæmatobia they are concealed.

They live by preference in damp situations, and their ordinary nourishment consists of the sap of flowers; but the females attack animals, and although their soft proboscis cannot pierce the skin, and only allows them to suck up the secretion thrown out on its surface, they harass and torment them most stubbornly. They are found in the company of the Flies—which they much resemble externally—around the eyes, nostrils, etc.—sometimes in veritable swarms. The best-known species is the Storm-fly (*Hydrotæa meteorica* Rob. D.). Linnæus termed it the *meteoric Fly*, because at the approach of rain it formed a kind of cloud towards the lower extremity of the Horse's head.

It remains to speak of a species in the family of Muscidæ, which does not belong to our country, but which cannot be passed over in silence, because of the universal evil reputation it enjoys. This is the *Tsetse*, or **Glossina Morsitans** (Westwood), which, by the organization of its proboscis, comes near the Stomoxys and Hæmatobia. It is a little larger than the domestic Fly; its slender proboscis is nearly twice as long as its head; its thorax, chestnut in colour, is marked by four black longitudinal lines; the abdomen is yellowish-white, and has only five segments, the last four of which have large black spots interrupted on the middle line; the wings are slightly smoky.

There are besides several Flies of tropical Africa, known by the common names of *Tsetse*, *Tsetze*, and *Zimb*, forming part of the genus *Glossina* (Wiedemann), and remarkable for their elongated proboscis, which allows them to puncture with force. The most celebrated is the *Gl. morsitans*, also named the *Tsaltsaya*. It constitutes one of the most serious obstacles to civilization

in Africa, for in the regions it frequents it renders the employment of the majority of beasts of burden impossible.

We will borrow from Railliet an excellent *résumé* of the history of this insect :

'The Fly to which the negroes give the name of *Tsetse* is met with throughout nearly the whole of Central Africa. It appears to prefer hanging about the borders of marshes and watering-places, and in beds of reeds. It makes a loud buzzing noise, which is easily recognised again when it has once been heard. If Bruce is to be believed, the buzzing of the Tsetse is "a mixture of dull and sharp sound, which is somewhat discordant. This buzzing causes more terror and disorder among men and animals than the monsters of the countries they inhabit could produce, if they were twice as numerous."

FIG. 8.—Tsetse, natural size.—Railliet.

'Many travellers—among others, Livingstone and Oswald—have stated that this Fly is one of the most redoubtable scourges of the African torrid zone; nevertheless, the descriptions published with regard to it have, it appears to us, something of a legendary character. Like the Stomoxes, the Tsetse attacks Man and animals. It darts on the latter, say the travellers, with the rapidity of an arrow, and prefers biting them inside the thighs or beneath the belly, and a tumour soon forms at the part attacked.

'It has been said that this insect prefers the uncovered parts of the body; that the action of its bite on Man is no more dangerous than that of the Gnat; that the domesticated animals, on the contrary—with the exception of the Ass, the Elephant, and the Goat—begin to waste away immediately, and soon succumb; that Dogs resist the bites when they are fed on venison, but perish when they receive milk; that Calves nourished on milk, on the contrary, are exempt from injury, etc. On autopsy, the heart, lungs, and liver are found more or less affected.

'The majority of these descriptions of the older travellers have been contradicted by more recent observations. Thus, a Belgian expedition has lost several Elephants; P. Baur has witnessed several of his Asses perish as a result of the stings of this Fly, and he asserts that, instead of preferring uncovered parts, the Tsetse usually gets underneath the clothing and up the sleeves of men, and below the tails of animals. Others have observed that those bitten generally succumb as a consequence of the gradually-increasing weakness, which may continue for several weeks, and even months. Finally, the most careful autopsies have not revealed any lesion of the spleen, liver, lungs, or brain.

'All these contradictory statements show that the action of the Tsetse punctures is extremely variable, and that, consequently, they ought not to be venomous. Besides, Nocard and myself have introduced, without any result, beneath the skin of the thigh of a Sheep the head and proboscis of a Tsetse, brought from Zanzibar a short time before by Paul Leroy.

'In reality, the Tsetse can merely be regarded as a carrier of virus, and its bite is only dangerous when its proboscis has been previously infected. With regard to the virus that it habitually inoculates, it is difficult, in the present state of our knowledge, to say what it actually is; but contrary to what Mégnin has advanced, it is impossible to say it is that of anthrax—at least, in the majority of instances. We have already given the opinion that it might well be the virus of various maladies, and, perhaps, even of affections peculiar to Central Africa.'

Later investigations have shown that Nagana or Tsetse-fly disease, is caused by a hæmatozoon, the *Trypanosoma Brucei*, and that the *Glossina morsitans* is capable of transmitting this parasite to Horses and other animals.

The small family of **Pupipara,** or **Hippoboscidæ,** naturally concludes this list, for the Insects composing it live exclusively as parasites, either on Mammals or on Birds. The name has been

given to it by Latreille, as the family does not lay eggs, but pupæ or nymphæ. In reality, according to Leuckart, the eggs developed in the ovaries undergo, in a dilatation of the vagina, the evolution which leads to the formation of larvæ; the latter remain in this organ, where they are nourished on the secretions of the glandular appendages of the uterus, undergoing several moultings, and acquiring their development before expulsion. Immediately after this hatching, they are transformed into pupæ. Therefore, the term 'Pupipara' is not quite exact. In the pupa state, the insect is in the form of an egg, nearly as large as the abdomen of the mother, this region being covered by a continuous membrane, without distinct rings, and capable of great dilatation—a structure necessary to the female, from the peculiar manner in which she brings forth her progeny. When the pupa case is expelled it quickly becomes hard, and suddenly enlarges to a greater size than the abdomen itself in which it was contained. The larger end has a sort of hood, which the insect scales off as soon as it is ready to make its escape.

These Insects have a flat broad body of leathery consistence. The rostrum comprises only a sucker, formed of an extensible tube contained in a setiform, horny sheath, which is in its turn protected by two velvety valves. The antennæ are rudimentary, and usually reduced to scarcely apparent knobs. The legs are strong, and terminate in dentated hooks. The wings may be absent, and the insect is then a permanent parasite, like the Louse.

Only two species of Pupipara interest us. One is the Melophagus of the Sheep, and is apterous—consequently a permanent parasite, and does not enter the group now under consideration. The other is *Hippobosca equina* (Linn.), which lives in intimate relation with the domesticated animals, but being provided with wings, easily quits its host, and therefore belongs to the group of remittent parasites.

FIG. 9.—*Hippobosca equina*, magnified two diameters.—Railliet.

The Hippobosca of the Horse, *Spider-fly* (Réaumur), or *Flat-fly*, is about 8 mm. in length. The head is yellow, has a brown spot at the summit, and is salient and distinct from the thorax; the eyes are dark. The thorax is brown, with three yellow spots, one at each anterior angle, the other median, posterior and triangular; the scutellum is white, margined with brown. The abdomen is yellowish-brown. The legs are deep yellow, with some brown bands, and the tarsal hooks are bifid. The wings are oblong, rounded, fuliginous, and have nervules only in their antero-external third. The body is covered with short stiff hairs at intervals. According to Leuckart, the transformation from the pupa into the perfect insect requires about a month.

This Insect is very common in summer, and sometimes attacks Cattle and Dogs, but it more particularly selects Horses, fixing itself on their flanks, and especially on smooth parts—as around the anus and vulva, and on the perinæum and inner aspect of the thighs. It runs with rapidity on the body of its host, and certain

animals which are particularly sensitive to its presence kick furiously at the contact of a single Fly. Habit, in the course of time, overcomes this irritability, and Horses learn to endure swarms of these insects without disturbance. They are very difficult to drive away, always obstinately returning, and their coriaceous integument resists a moderate degree of pressure intended to crush them. When animals are badly groomed, the Fly only leaves them at long intervals.

Rondani has separated into three species the different forms which the *Hippobosca equina* may present. Thus he distinguishes: *H. canina*, which attacks various Mammals, but more particularly the Dog; *H. equina*, which torments Horses, Cattle, Dogs, and other animals; and *H. taurina*, found on the Ox.

Preventive and Curative Measures against the Action of the Diptera.—The various Diptera, generally designated by the name of Flies, cause different degrees of injury to the health of animals. At least, they prevent them resting in their habitations, and they increase their fatigue during work by the superfluous movements and inconvenient attitudes they compel them to assume. It is, therefore, useful to endeavour to prevent their approach.

What is most necessary is to keep them away from the interior of habitations, or, at any rate, to destroy them there. The first object to be attained is keeping these in comparative darkness; but curtains, blinds, and shutters interfere more or less with the ventilation. A procedure indicated by Spence as resorted to in Italy, which avoids this inconvenience, 'consists in providing the windows externally with a simple net, the meshes of which may be wide enough to allow several Flies to pass through at a time. If the light enters at only one side of the building, the Insects will not venture to traverse the net; but if, on the contrary, there is a window in the opposite wall which admits the light, they will not hesitate to enter' (Railliet).

When Flies have entered the dwellings, it is somewhat inconvenient to endeavour to expel them by means of certain odorous substances, and it is preferable to impregnate certain parts of the bodies of the animals themselves with a solution of bitter, nauseous materials, such as those mentioned below. In some countries, while the animals are out of doors, it is customary to burn the dry leaves of the pumpkin, the acrid smoke of which immediately drives out or kills the Flies. In other countries, small bundles of heather, broom, willow, or ferns, are suspended from the ceiling or walls, and in these the Flies take refuge during the night, and while they are asleep the wisps are shaken over a fire and the Insects in this way destroyed.

During work or while at pasture, animals can be protected by means of covers and linen sheets. The garniture most employed with this object is the net that is spread over the bodies of Horses and working Oxen, which is bordered by a fringe of twine, the con-

tinual movement of which keeps away Insects. Sometimes this fringe, fastened to the reins on each side, constitutes all the caparison; and only too frequently the protection for the Ox is reduced to merely a bit of cloth covering the face, and defending the eyes and muzzle. The abdomen is sometimes protected by a kind of linen apron. The *bonnet* or *hood* which envelops the ears, neck, and face prevents the entrance of Flies to the ears. Much employed in the east of France and in Germany, this is made of net, or, better, of linen. These contrivances are often replaced by twigs and branches of trees, which, tied to the saddlery, by their continual movement drive away the Insects.

Finally, the bodies of animals may be dressed with odorous, bitter, or nauseous substances. In many countries, use is frequently made of a decoction of walnut-tree leaves, or of a maceration of them in vinegar. This need only be applied to the skin once a week. Sometimes it is sufficient to merely rub the animals with the walnut-tree leaves. There have also been recommended weak decoctions of tobacco, aloes, and assafœtida. Substances should be avoided such as empyreumatic oils—which soil the harness and the coats of the animals, and are not superior in their effects to those just mentioned. The lotions and frictions need rarely be generally applied, but should rather be localized on the regions of the body which are most sensitive, or which are most exposed to attack.

There are no particular instructions to offer with regard to the accidents that may sometimes be occasioned by the dipterous parasites; and attention has only to be directed to the local or general phenomena which present themselves. Usually cold affusions, douches, and local or general bathing, cause the disappearance of the tumefaction and pruritus that are manifested and it is only these that appear to demand therapeutic intervention.

CHAPTER II

DIPTEROUS PARASITES OF THE SKIN IN THE LARVAL STATE

A CERTAIN number of Diptera pass their larval phase either in wounds on the surface of the body, or in the substance of the skin itself. Sometimes this sojourn is only accidental for them, and at other times it is absolutely necessary. Parasitism is, therefore, less complete for the former than it is for the latter, which only comprise the larvæ of the Œstridæ, and which are, for this reason, named *cuticoles*.

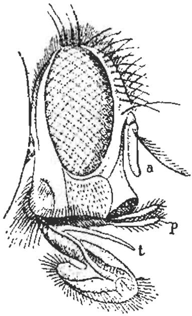

FIG. 10.—Head of the Blue or Flesh Fly, highly magnified.—Delafond.

a, antennæ; *p*, maxillary palps; *t*, proboscis.

All these larvæ are acephalous; the anterior extremity is destitute of eyes and antennæ, and has, at most, two horny hooks; food is introduced into the mouth by suction. On transformation into nymphæ, the skin becomes hardened and assumes the form of a small barrel (*barrelled pupa*), in the interior of which is the real pupa. The perfect Insect makes its escape by raising a more or less rounded valve.

The term *Myiosis* designating every disturbance due to the larvæ of Diptera, it is naturally only a question here of *Cutaneous Myiosis*. This is caused by the larvæ of the Muscidæ and Œstridæ —sub-orders of *Brachycera*.

LARVÆ OF THE MUSCIDÆ.—The latter belong to the genera *Sarcophaga*, *Lucilia*, and *Ochromyia;* for it is not proved that the **Blue Flesh-fly** (*Calliphora vomitoria* L.), which contributes so largely to changes in meat, nor the **Carnivorous Sarcophagus** (*Sarcophaga carnaria* L.), or **Gray Carnivorous Fly,** really deposit, even accidentally, their eggs and their larvæ on wounds. On the contrary, it is now known—thanks to Portchinsky—that the majority of larvæ which are found in Europe on the wounds of Man or animals, are those of

the **magnificent Sarcophagus** (*S. magnifica* Schiner, *Sarcophila Wohlfarti* Portch.), which, according to Laboulbène, has the following description:

Length 10 mm. to 13 mm. General colour gray; face and sides of head white; antennæ and palps black; thorax ash-gray, with three black longitudinal lines; abdomen light-gray, with three black spots on each segment. Wings hyaline, base yellow. Legs black.

Like the other species of Sarcophaga, this one is viviparous; the females deposit their larvæ in wounds on Man and animals.

These larvæ are fusiform, with very distinct segments, and destitute of spines; the buccal extremity is furnished with two hooks; the posterior extremity shows two stigmata—openings of the respiratory apparatus.

FIG. 11.—Blue Flesh-fly, natural size.—Railliet.

FIG. 12.—*Sarcophaga magnifica*, male.—Laboulbène.

'This Dipteran,' says Portchinsky, 'is entirely rural, and is never seen in houses. In the perfect state, it is difficult to find, and it can only be procured by hatching the nymphæ obtained from the larvæ gathered on animals' wounds. It is one of the finest of the *Sarcophila*, and it is not only very annoying to Man, but also to animals, in the Government of Mohilew. In fact, I have obtained the *Sarcophila Wohlfarti* exclusively from different larvæ derived from Cattle, Horses, Pigs, Sheep, Dogs, and even domestic Birds—chiefly Geese. In certain years, the infection of Cattle by the larvæ of Flies extends to two-thirds, or to at least one-half of a herd. An insignificant wound is suddenly invaded by these larvæ, and it soon becomes considerable. This species prefers the mucous membranes, but more particularly the inguinal region of Cows, where the larvæ cause extremely serious sores; this occurrence is frequent here. With Dogs, the same larvæ are often met with in the ears, and it is not rare to see them at the same time punctured by legions of *Stomoxys calcitrans* and covered with blood.'

Mégnin mentioned having found the larvæ of this Fly not only in wounds of the domesticated animals, but also in the depressions or folds of skin where the sebaceous secretion is always in a state of more or less ammoniacal fermentation—such as the lacuna of the frog of the Horse's foot, the cavity of the prepuce, or hollow of the pastern of that animal. In these places the larvæ finish by

inducing ulceration of the skin, and they may even sometimes penetrate beneath it, causing more or less considerable disturbance.

After their transformation into nymphæ, Mégnin has, by hatching them, always obtained the same Fly—*Sarcophaga magnifica*. He is of opinion that it is these larvæ which are most frequently found in wounds in Man, and that if they are mistaken for those of the *Calliphora vomitoria*, *Sarcophaga carnaria*, and *Lucilia Cæsar*, it is only because they all resemble one another so much that they cannot be distinguished, except by hatching out the perfect Insect —which is rarely successful.

The genus **Lucilia** (Rob. D.) contains Flies with a soft proboscis; the epistoma—the superior border of the buccal cavity—is not salient; the antennæ to the third article are quadruple the size of the second, and the stylet is very plumose; abdomen short and round, wings wide apart. These characters, joined to the bright metallic colours, constitute a *facies* which distinguishes this genus from all the others.

The **Lucilia Cæsar** (Linn.) is the type; it is of a fine golden-green colour, is widely extended, and deposits its eggs on decomposing organic matter. It lays them also on the wounds of Man and animals.

The **Lucilia sericata** (Meig.) much resembles it.

It is smaller and of a greenish-blue tint. The epistoma and face are white, while the first is of a pale red in the Lucilia Cæsar. The first ring of the abdomen alone is black, while in the other species the second ring, in addition, has a black dorsal line.

In Holland, the Lucilia sericata often causes an affection of a certain gravity in Sheep, which the breeders designate the 'worm sickness' (*Worm-ziekte*). It was first studied by Bouman and by Gerlach, then by Jennes and Van Laer.

The larvæ are found chiefly in young Sheep, and especially those suffering from diarrhœa; adult Sheep being seldom troubled by them unless they are badly kept. Attracted by the fæcal matters about the hind-quarters of the animals, the flies there deposit their eggs, and from these issue small cream-coloured larvæ, formed of ten to twelve rings, with points on their borders. The head has two hooks, and the posterior extremity, more voluminous, shows three stigmata. These larvæ attack the skin and cause itching, which compels the animal to keep its tail continually in motion, and to bite and rub itself against surrounding objects. The wool is then very closely matted, and in hard patches, beneath which the skin is perforated by small openings or is largely abraded, and a thick viscid fluid of an unpleasant odour is discharged from it. When exposed, the larvæ are greatly disturbed, run away in every direction, and try to conceal themselves beneath the skin. They are sometimes found towards the croup. If the disease persists, it complicates the diarrhœa, and contributes to bring about marasmus in the young animals. This condition is observed among sheep in the United Kingdom which are said by the shepherds to be affected with the 'fly' or 'maggot.'

Another better-known species is the **Lucilia macellaria** (Fabr.), more frequently designated the *L. hominivorax* (Coquerel) and *L. anthropophaga* (Conil.). It measures 9 to 10 mm., and is recognised by its blue thorax streaked with three darker blue bands of a purple tint; the legs are black, and the wings brown at the base. The larva measures 14 to 15 mm. This fly is met with over a great portion of America, from the north of the United States to the Argentine Republic; but more particularly in the warm regions. It is redoubtable because of its larvæ.

It deposits its eggs in the wounds of the domesticated animals and Man, and even introduces them into the natural cavities. By means of their two buccal hooks, the larvæ attack the tissues and rapidly produce serious disorder, with loss of substance and mutilation. The facts published with regard to this interesting insect are chiefly concerning Man. Liguistin has, nevertheless, observed extremely grave complications caused by the larvæ of this Lucilia in wounds, and more particularly in the ulcerations (*crevasses*, cracks or *fissures*) from which the Horses and Mules suffered during the (French) expedition to Mexico.

The last species of this group of parasites is the **Ochromyia anthropophaga** (E. Blanchard). Railliet, who has particularly studied it, thus describes it: 'A fly of a grayish-yellow tint, measuring 8 to 19 mm. long. The head is testáceous and covered with small black hairs; the style of the antennæ is plumose. The thorax has, in front, two black longitudinal bands; the wings are slightly smoky. The abdomen is covered with somewhat large black spots, particularly behind.

'It is a Senegal Fly, met with principally in the Province of Cayor—hence the designation of *Cayor-fly* by which it is generally known. It has been seen sometimes to hover over animals (Notaris); nevertheless, it appears to deposit its eggs in the sand. In any case, it is observed that the larvæ, known by the improper name of *Cayor-worms*, develop beneath the skin in Man and various animals—Dog, Cat and Goat. With the Dog, which is more particularly affected, a small inflammatory tumour is seen, which increases rapidly and is covered by a brown crust. In about six or seven days the larva has completed its evolution, and leaves this tumour in order to be transformed into a pupa, cicatrization of the wound being spontaneously effected.

Fig. 13.—The Cayor-fly, magnified two diameters.—Railliet.

'When the parasites are few in number, they occupy the tail by preference, as well as the paws and ears—parts in contact with the ground. But if, on the contrary, they are numerous, they are found on all parts of the body. Young animals are oftenest attacked, but adults may be so seriously invaded as to succumb. It is remarkable that this parasite abounds at Mount Pal, about twenty miles from St. Louis, while it has never been seen at the latter place; and what is more, Dogs which enter St. Louis covered with larvæ are free from them in about two days.'

R. Blanchard considers the Cayor-fly as belonging to the family of Œstridæ, and allied to Hypoderma and Dermatobia.

Prophylaxis and Therapeutics.—The prophylactic measure to be opposed to myiosis consists in preventing the approach of the Flies, and has been sufficiently indicated in the preceding chapter. In the case of wounds, and in view of their usually small dimensions,

it is advantageous to apply some empyreumatic oil, as oil of cade, around them; its strong and persistent odour allows of its employment in very small quantities.

It is evident that dressings carefully performed, and sufficiently frequent, will prevent the invasion of wounds by larvæ; and thorough cleansing will expel them from the parts (prepuce, frog, pastern) where they may lodge. Keeping the wool of the Sheep clean will prevent the visits of the *Lucilia sericata;* and as for the Cayor-fly, the prophylactic measure, says Lenoir, is to prevent dogs from lying on the sand, or, better still, keep them away altogether from the usual haunts of that insect.

The curative treatment is very simple, for the larvæ are very sensitive to an infinity of agents that cause but little irritation to the wounds that harbour them, and they are easily killed or expelled. So that they may either be removed immediately, or treated with ether, chloroform, benzine, petroleum, tincture of camphor, etc.

LARVÆ OF THE ŒSTRIDÆ.—Although the larvæ of the *Œstridæ* infest the subcutaneous connective tissue, their study naturally comes in here, for their presence is associated with perforations of the skin.

An essential characteristic of the Œstridæ is the necessary parasitism of their larvæ. Guided by a special instinct, the female lays her eggs on the bodies of Mammalia, choosing the species to which their future development is subordinate. In order to be hatched, the larva employs various means to reach the organ or region most suitable. Sometimes it is the subcutaneous connective tissue, and in other instances it is the frontal sinus, or pharynx, the stomach, or intestine. It remains in its special habitat for a variable period, generally from the summer until the following spring, when it contrives to leave it by a mode of procedure appropriate to each type, and buries itself in the ground, conceals itself beneath a stone, or seeks the shelter of some place which is a little damp, where it may become transformed into a nympha or pupa, before appearing in its perfect state. The latter is generally somewhat rare to find.

The Œstridæ are recognised by the following characters:

Body usually hairy; head somewhat voluminous and hemispherical; two faceted eyes, usually separated by a broad forehead, which bears three ocelli; antennæ very short, fixed near the forehead, and folding into two corresponding cavities which are completely or incompletely separated. Of their three articles, the last, which is almost globular, has a dorsal bristle or stylet, inserted near the base, and usually simple. Proboscis generally very small, or scarcely visible; two palps sometimes distinct, sometimes rudimentary; thorax large, elevated, and prothorax very marked; wings large; abdomen formed of six apparent rings, the extremity being rounded in the males, and terminated by a very extensible oviscapt in the females.

Certain species are viviparous, bringing forth the larvæ already hatched; others are oviparous, laying eggs of different shapes,

with a resisting shell sometimes operculated, which always present at its posterior pole an appendage that serves to attach the egg to the skin or to the hair of the host. The number of larvæ or eggs which each female deposits is always considerable.

The bodies of the larvæ are composed of twelve segments, the first two of which—cephalic segments—are not always very distinct from each other. Between these two first segments are two very small respiratory stigmata—*anterior* stigmata—in the form of points, nodules, or minute slits; these are sometimes concealed in a depression in the integument. The last segment has also two stigmata—the *posterior*—consisting of openings into which the tracheæ may project, or in large peritremes pierced with a variable number of openings. At their birth the larvæ have external buccal organs, formed chiefly of two hooks, which sometimes persist, or disappear as development progresses. Above these buccal organs are seen two small horny or cutaneous projections, which represent the antennæ. The anus is very small, and is situated below the stigmatic plates of the last ring. During their parasitic existence, the larvæ undergo two moultings, which divide this period into three stages.

When the larva has quitted its host and reached a place favourable to its nymphosis, its skin becomes hardened, and is detached from the body of the nymph, the covering of which is supple, and to which it sometimes remains united by four tracheæ. The shell, more voluminous than the insect which ought to leave it, is distended at its posterior part by fluid that afterwards escapes. The nymphal state continues from three to eight weeks, and even longer if the weather is cold. At the instant of hatching, the Insect, by means of a vesicle which is developed on its forehead, makes such pressure on the inner surface of the shell as to cause this to rupture at the cephalic extremity, and in the direction of the sutures of its arches. The wings of the newly-hatched creature are extended in ten to fifteen minutes.

In this perfect state, with their mouth atrophied, the Œstridæ appear to be no longer able to take food; they may live, nevertheless, for several weeks on the fat accumulated in their bodies. Quiescent until their reproductive organs have attained their maturity, they then exhibit an extreme vivacity, particularly if atmospherical conditions are favourable. They fly chiefly during the warmest and finest days of summer, and during the middle of the day, and they generally frequent pastures in the vicinity of woods.

FIG. 14.—Wing of the Ox Hypoderma, magnified five diameters.

According to the particular habitat of the larvæ, the latter and the species to which they belong are distinguished, since the time of Bracy Clark, as *gastricolæ* or *chylivorous*—gastric or intestinal; *cavicolæ* or *lymphivorous*—those frequenting the cavities of the face; and *cuticolæ*—those which are subcutaneous.

Brauer, whose works on the Œstridæ constitute him an authority, has arranged all the species into thirteen genera, only four of which—*Hypoderma*, *Dermatobia*, *Cuterebra*, and *Œstromyia*—are cuticole larvæ. Of these four genera, the first two alone develop their larvæ beneath the skin of the domesticated animals, in Europe or

other parts of the world, and are consequently only those which will be noticed here. From a zoological point of view, they belong to the group whose wings have a terminal transverse nervure (Fig. 14).

Hypoderma.—The European cuticole Œstri belong to the genus *Hypoderma* (Latr.).

In the perfect state, the body of these Insects is hairy; the head is generally larger than the anterior part of the thorax; the antennæ are very short, and the stylet nude and deeply buried in two separate depressions. The proboscis is quite rudimentary; the thorax is nearly spherical, and generally larger than the abdomen. In the female, the ovipositor (Fig. 16) is long, consists of four articles, and is continuous with the fifth ring; the segments composing it pass within each other in telescope fashion. When it is extended it projects backwards and slightly upwards, and at the end of the last article are three horny appendages, a little curved inwards toward each other like pincers, between which the eggs pass out. The wings, most frequently fuliginous, are small, divergent, and inclined outwards.

In the first stage, the larvæ are free in the subcutaneous connective tissue, in the panniculus carnosus, and sometimes under the fasciæ of the superficial muscles. The skin covering them does not show any perforation, this being obliterated after giving passage to the young larva. The duration of this period appears to be several months.

At the end of this time the larva is about 13 mm. long; it is nearly cylindrical, and only about 2·2 mm. thick. The mouth, which is altogether anterior, has, above, a salient stylet, completed on each side by a hook curved almost at a right angle. These hooks can be brought together so as to become parallel to the median stylet, and thus form a point well adapted to bore through the tissues, while by their separation they are opposed to withdrawal and facilitate progression. It is doubtless by this mechanism that the newly-hatched larva can penetrate beneath the skin. This larva is formed of eleven rings; it is white except at the mouth, pharynx, and posterior stigmata, where it is brown. The stigmata consist of thin, porous plates of chitin, which do not yet perfectly fulfil their rôle of respiratory openings. This function must be accomplished partly by the skin—which is thin, almost transparent, and nude—if it is not carried out in the infundibuliform depression of the mouth and on the border of the lower lip, where there are two microscopical spines.

In the second stage, which occupies about a month, the larva increases in dimensions in every direction, but preserves its white colour except at the inferior surface, which presents black spots formed by agglomerations of microscopical spines. The upper surface is nude, with the exception of the first two or three rings. The mouth is V-shaped and circumscribed by plates of chitin; the stylet and hooks have disappeared. The plates of the posterior stigmata are reniform and have large alveoli. The posterior extremity is thin, the anterior expanded and vesiculate.

The third stage lasts two to three months. The larva becomes thick, pyriform, and almost spherical in a state of contraction; it has the shape of a boat when elongated, being convex below and plane above. Soft, flexible, and very contractile, it becomes yellow, then brown, and finally black. The buccal fossette is infundibuliform, with the rudimentary antennæ above it. At the upper surface of the cephalic extremity is a slight horseshoe-shaped furrow that extends to about the fourth ring. This furrow encloses the part which, at the termination of nymphosis, is detached by the Insect, in the form of an operculum. Each ring, from the second to the ninth, carries three pairs of lateral ridges ranged beside each other and garnished with spines, the disposition of which varies according to the species; the last ring is hemispherical or cylindrical.

Three species of Hypoderma with larvæ parasitic in the domesticated animals are actually known: the *Striped Hypoderma*, the *Reindeer Hypoderma*, and the *Bovine Hypoderma*. The latter belongs more particularly to this country, and has been the longest recognised.

The **Striped Hypoderma** (*H. lineata* de Villers) is black, very hairy, 12 to 13 mm. long, and derives its name from the gray longitudinal bands on the upper surface of the thorax. It has been found in England, Norway, Germany, Italy, Southern Russia, and in Kentucky, America. Brauer supposes that its larva lives beneath the skin of the Ox, and that it must be included among the larvæ of the Œstridæ which have been several times observed in Germany beneath the skin of Sheep recently clipped.

The **Reindeer Hypoderma** forms the sub-genus *Œdemagena* (Latr.), which is only distinguished from the Hypoderma by the latter having no palps, and the spines on the surface of the larva being fewer on the lower than on the upper surface; while in the Œdemagena palps—small and globular—are present, and the two surfaces of the larva are equally spinous.

The Hypoderma of the Reindeer (*H.* (*Œd.*) *Tarandi* Linn.) is black and very hairy. The female—larger than the male—is 16 mm. long. The thorax is covered with yellow hair, and has a wide, black, transverse band. The first segment of the abdomen is covered with pale-yellow hairs, the other segments with short hairs. The thighs are black: legs and tarsi grayish-yellow.

The larva is in every way larger than that of the Ox Hypoderma, which it much resembles in other respects.

This species is found in Lapland and North America.

Linnæus states that it inspires so much fear in the Reindeer, that ten of the Insects will alarm a herd of more than five hundred. As soon as they appear, the Reindeer tremble, run about, snort, bellow, and stamp their feet. He also mentions that the female—as with other species of Hypoderma—only deposits its eggs on the skin of these animals. Once hatched, the larva penetrates beneath the hide of its victim, and is there nourished after the manner of the Hypoderma bovis.

The Insect deposits its eggs early in July, when the Reindeer has shed its coat. It prefers to attack young animals, though it does not spare the old; it pursues them in the valleys, among precipices, and even on the icy mountain-tops. In their agitation, the Reindeer can scarcely settle down to feed, and it is not uncommon to see them lying down all the day before the hut of their owner, without attempting to eat, in order that the thick smoke issuing from the habitation may preserve them from the attacks of the Œdemagena. The larvæ are, however, not numerous on the same animal, being six to eight on young deer; but their presence causes much emaciation, and sometimes they are blamed for destroying as many as one-third of the young animals (N. Joly).

The **Ox Hypoderma** (*H. bovis* Geer) is by far the most interesting of the cuticole species, for it is abundant, and extends from Scandinavia and North America to the South of Europe, and to Asia and Africa. It has the following characters (Fig. 15):

Black, very hairy. Face gray, with white or yellow hairs. Similar hairs on anterior half of the upper surface of the thorax, black on the posterior half, and marked by broad longitudinal bands of shining black, close together. Abdomen black, covered with white or yellow hairs at its base, black in the middle, orange-red in its posterior third. Legs black at the base, yellow in their terminal moiety; wings somewhat brown. Length, exclusive of the ovipositor, 13 to 15 mm.

In its perfect state, this insect lives during the months of July and August, and may even be met with in the first days of September.

It is particularly well known, from the fact that it can be artificially hatched when the larva is extracted from the Ox's skin and kept in favourable conditions. The female is provided with a soft, short,

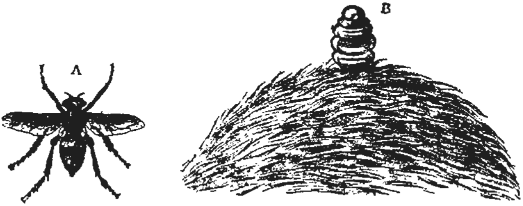

FIG. 15.—Hypoderma of the Ox.

A, Female, natural size. B, Larva, making its exit from a tumour.—Réaumur.

black, cylindrical oviscapt, which is folded beneath when the Insect is resting, and which serves to deposit its eggs on the skin of bovines while they are out of doors. It prefers the upper parts of the body

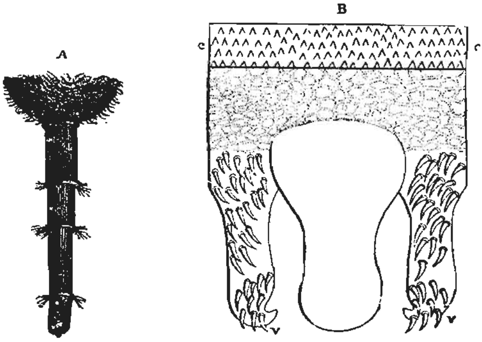

FIG. 16.—Hypoderma of the Ox.

A, Extended ovipositor, magnified.—Réaumur. B, End of this ovipositor, highly magnified ; *e*, spines which cover the outside of the second last tube of the ovipositor ; *v*, vulvar tentaculæ ; *c*, middle piece of the spoon.—N. Joly.

—the shoulders, back, loins, croup, sides and flanks. Its flight is rapid and accompanied by a buzzing sound. When it is about to lay its eggs, it flutters above the back of the Ox for a minute or

two, then suddenly drops, deposits an egg on the skin, rises in the air, again flutters, descends with rapidity as before, and drops another egg. This manœuvre is repeated ten or twelve times in a quarter or half hour.

It is a widespread belief—which the majority of authorities have subscribed to—that the approach of the female Hypoderma causes great terror among cattle: they are restless, become more and more agitated, and finally start off in a frantic manner, with tail horizontal, until beyond the sound of their enemy. Sometimes they plunge into water to shelter themselves from the dreaded pursuit; and in this way accidents may occur. This fear is contagious, and one Hypoderma will put to flight a whole herd: it is even sufficient, it is said, to closely imitate the buzzing of the Insect to realize the same moral effect, and to this trick is often attributed the stampedes among Cattle which sometimes occur at fairs.

Virgil is considered the first writer who has described the fear that the Œstrus inspires in herds ('Georgicorum,' lib. iii.); but it is more than doubtful that the Insect which he mentions belonged to the family of Œstridæ; and, on the other hand, doubt has been thrown upon the correctness of the popular belief which, from the time of Virgil, has been transmitted to our own day. It is really founded on the dread the Ox may experience, of the puncture the female Œstrus makes on implanting each egg in the skin. But it is well established that the oviscapt (ovipositor) of the Œstrus is not adapted in any way for boring, and is merely a depositing apparatus; consequently, egg-laying does not cause any pain to the host. Bracy Clark first, and Hertwig afterwards, remarked on this fact; and, besides, Goudot, who has personally experienced the effects of the larvæ of the Dermatobia, asserts that he never heard or saw the flies, much less felt them deposit their eggs on the uncovered parts of his body, and is inclined to attribute the fear of animals on the approach of the Dermatobia to an instinctive prevision of the future trouble that awaits them. On the other hand, it may be asked if the share the Hypoderma has in causing fear among Cattle is well founded, or if fear is not rather due to the cattle being unable to discriminate between the buzzing made by the Hypoderma and that of the Breeze-flies, Gnats, and other Diptera which torment animals under the same circumstances—that is, in hot and stormy weather. Although Brauer, who is responsible for the statement, says that two females of the *Hypoderma Actæon* have been seen depositing their eggs on the backs of Deer without these appearing to notice them, yet he is careful not to draw an inference from one species to another. On the contrary, he brings forward a document to prove that here, also, popular observation cannot be relied upon without an imposing array of facts to support it. It is a letter from Schleicher, an intelligent farmer of Gresten, Austria, who had seen the perturbation caused by the Hypoderma, and was able to capture the Insect in the act of laying, forwarding it to

Brauer, who recognised it as a female *Hypoderma bovis*, with an egg still between the pincers of its oviscapt.

It is probable that the ova are deposited on the skin itself, or at the hair-roots; but no one has seen them there. Those who have described the eggs have obtained them directly from the female, by slight pressure on the abdomen:

These eggs (Fig. 17, B, C) are white, elongated, spindle-shaped and a little flattened; they have a posterior pole, with a brownish appendage, which appears to be used to make the egg adhere to the hairs; they are 1·25 mm. long. The duration of incubation is not known, neither is the form of the larva in the *first* stage. However, C. Curtice considers—and in this he is supported by C. V. Riley—as belonging to this first stage of the *H. bovis* larvæ of from 10 to 15 mm. long and 1·5 mm. broad, similar to those of *H. Diana*

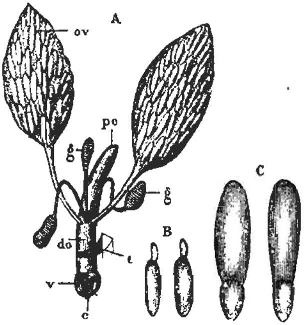

FIG. 17.—Hypoderma of the Ox.

A, Genital apparatus of the female: *ov*, ovaries; *pc*, copulative pouch; *do*, oviduct; *g*, annexed glands; *t*, portion of the second-last tube of the oviscapt; *v*, vulvar tentaculæ; *c*, middle piece or spoon. B, Eggs from the ovary. C, Eggs from outside the ovary.

figured by Brauer, which he found in the wall of the œsophagus, beneath the costal pleura, and in subcutaneous tumours on the back of Oxen in the United States.

In the *second* stage—which usually corresponds to the month of May and lasts about thirty days—the larva is club-shaped, and measures 13 mm. long and 4 mm. broad at the fourth segment. The lateral prominences are very salient; the microscopical spines of the integument are in small groups on the sides of the two first segments, at the anterior border and upper surface of the second and third segments, at the two borders and inferior surface of the second and ninth, and over the entire surface of the last.

At the *third* stage the larva is thick and pyriform, and the lateral prominences are still more salient. On the upper surface is remarked, at the anterior borders of the second to the fifth segments, small spines more numerous anteriorly than posteriorly; the same is seen at the posterior borders of the second to the seventh or eighth; and the same also at the superior and middle

prominences of the second to the fifth segments. On the inferior surface, the spines running along the two borders of the second to the ninth segments are larger on the anterior than the posterior border; and it is the same on the anterior border of the inferior lateral prominences from the second to the eighth segment. The two last segments are completely unarmed. The skin is wrinkled and furrowed, and is at first white, except where the spines and stigmatic plates are; there it is of a dark brown. As age advances, the larva assumes a grayish-yellow tint, then it becomes speckled with brown, and finally becomes blackish-brown at complete maturity, which occurs in June or July, exceptionally in August. It then measures 22 to 28 mm. long, and 11 mm. to 15 mm. broad, at the eighth segment.

Larval existence is passed beneath the skin of the host, in the subcutaneous connective tissue, in the panniculus carnosus muscle, or under the aponeuroses. In the earlier period, no irritation is remarked around the parasites; but when spring arrives the presence of the larvæ is made manifest externally by tumours, the size of which increases with the development of these creatures. The number of the tumours is variable; there are rarely fewer than four or five, and usually there are ten to twenty, sometimes as many as fifty, and even one hundred have been counted. They are of unequal volume, but seldom exceed the size of a nut; they have the characters of a cold abscess, are not abnormal in temperature, nor markedly painful. At their summit, or towards their base, they are pierced by an opening which is at first little apparent, but which measures from 4 mm. to 7 mm. in diameter in those tumours from which the larva is about to escape. From this opening flows pus, which dries and agglutinates the adjacent hairs; this comes from a subcutaneous abscess in which the larva is lodged. It is in the second stage of larval life that the tumour appears, and it is due to the presence of the parasite, which acts as a foreign body, irritating the tissues by the spines with which it is covered, and producing a moderate degree of inflammation that results in the formation of embryonic tissue in concentric layers. The skin is infiltrated and marked with ecchymoses and blood-stains. The opening results from a process of ulceration; there is no hole at first, although Stricker has admitted that the larva penetrates by the orifice of a hair follicle or sebaceous gland, and that the tumour of the Œstrus commences in one or other of these elementary organs. The larva almost exactly fills the sac, the shape of which is reproduced externally; and the creature is so placed in it as to present to the opening its oval anal extremity, furnished with the stigmated plates, while the cephalic end is turned towards the bottom of the sac. It is nourished not only by pus, but also by the blood of its host, as an abundance of that fluid is found in its digestive apparatus.

When the development of the tumour is somewhat advanced, methodical pressure at its base will readily cause the expulsion of the larva. A few days before leaving its abode, the creature enlarges the opening in the tumour by pushing at intervals the last segments of its body into it, until, finally, it emerges in a state of complete maturity—usually in the morning between six and seven

o'clock, as Réaumur had long ago remarked. Those larvæ which do not perish by being trodden upon by their host or devoured by birds, creep along by means of the hooklets on their inferior surface and the energetic contractions of their bodies, until they find a convenient place for their transformation into nymphæ; they then penetrate the ground to a depth of about two or three inches, or conceal themselves in hay, among leaves, etc. The nympha is about three-fourths of an inch long externally; in shape it is pyriform and expanded, its anterior extremity showing a plane, oblique surface turned upwards, and infringing on the superior surface. The condition of nympha lasts for twenty-five to thirty days.

After the larva has left its cyst, the formation of pus gradually ceases and the wound cicatrizes; though for a long time it bears traces of the alteration it has undergone, so that the skin is seriously depreciated in value, especially if the larvæ have been numerous. But it rarely happens that the animals themselves suffer in health, though it is doubtful if these larvæ exercise a salutary effect on the economy—preventing disease by acting as derivatives, according to Bracy Clark's belief. Lafore asserts that country people consider the presence of the larvæ as a proof that their animals are of good quality and that they fatten well; and they explain this belief by the instinct that impels the Hypoderma to deposit its eggs on animals with a fine supple skin. However this may be, it is certain that if aged animals are spared its visitations, calves are equally exempt.

The pecuniary loss occasioned in this country by the 'Warble-fly,' as the *Hypoderma bovis* is popularly designated in England, has been represented as very great, being estimated at as much as one pound per head on every animal unsheltered from its attack. Among dairy cattle, the loss has been estimated at three pounds per head.

The loss by damage to the hides is extremely heavy, and has been given as averaging one penny per pound weight, or five shillings and tenpence for each hide. One extensive hide-importing firm reports: 'Parcels of ox and cow hides and goat and sheep skins, coming from all parts of the world, all contain a varying proportion of warbled hides and skins, the damage being greatest, as a rule, on those from the hottest climates, and generally affecting goat-skins to the greatest extent. Those hides and skins from Mogador, and other northern parts of Africa, suffer most in this respect, an average of about one-fourth of them being damaged to the extent of 60 or 70 per cent. of their value. Those from Kurrachee, India, also suffer damage to almost the same extent; while those from Calcutta, Madras, and Bombay are depreciated perhaps to the extent of 50 per cent. on 10 per cent. of the skins. From Cape Colony the skins are comparatively slightly damaged, and still less are the hides and skins from Australia and South America' (Ormerod).

Treatment.—To preserve animals from the ravages of the Hypo-

derma, it is only necessary to employ one of the many measures indicated when dealing with the Flies. Brauer relates that, in certain localities where the Œstridæ abound, the inhabitants have succeeded in diminishing their numbers by not allowing cattle to pasture after ten o'clock in the morning from April to August. As the mature larvæ usually quit their host before that hour they fall on the cowshed floor, and not finding a suitable quarter in which to pass their nymphosis, they die; consequently, the species is much diminished. It has been remarked that such cattle are very much less visited by the Hypoderma than those of the Alps, in which the larvæ are exceedingly numerous, because the animals live out of doors night and day.

In order to free the skin from the larvæ which have invaded it, they may be extruded by pressure of the fingers, or they may be killed *en place* by introducing a lancet, or a bistoury, or a red-hot stylet into the orifice of the tumour. The same result can be obtained by the use of benzine, oil of turpentine, tar, or salt water. But these have the disadvantage of causing a long suppuration, in order to bring about the gradual elimination of the dead body of the parasite. It is, therefore, preferable in every respect to remove it at once, if necessary, through its exit orifice, by enlarging this and seizing the creature with forceps. Nothing more is then required than attention to keeping the wound clean and healthy.

In England, much attention has been paid to this subject of prevention and treatment, and many suggestions have been made and carried into practice. One experienced veterinary surgeon, H. Thompson, says: 'Respecting the application of anything to prevent the Warble-fly depositing its eggs, there are many substances of a tarry nature that might be applied, but nothing better than Stockholm or green tar. This should be rubbed along the back of the Cows before turning them out, and the dressing should last all the summer season. Or sheep-salve—bad butter and tar mixed with sulphur. About two applications should last a full season. Or the application of brine is useful. It is a common practice to wash the Cows' backs with pickling brine, the application being made two or three times during the season. In this part—Cumberland—large farmers keep what is called a "pickling-tub," wherein they put beef and mutton. The brine is made with salt and water, salt being added until an egg will float in it. This is an old remedy, and I think a good one, as I believe the ova would be destroyed immediately the mixture was placed on the skin. I have used, and also recommend, the following mixture as a preventive: sulphur, four ounces; spirit of tar, one gill; train or whale oil, one quart. Mix well together, and apply it to the spine of the Cow once a week with a small brush. The smell drives off the flies, and prevents them depositing their eggs, the cattle are left at peace to graze, and warbles thus prevented. Paraffin, kerosine, carbolic acid, phenyle, etc., are all too transient to be of much service, and would have to be frequently applied.'

The Hypoderma of the Horse.—Horses which are allowed to pasture during the summer season are sometimes found to be, in the following spring, more or less invaded by the larvæ of the Hypoderma. Vallisnieri, Huzard, sen., and Bracy Clark had already observed this. Roulin, cited by Joly, relates that, in the llanos of South America, the Horses which live there in a semi-savage condition, are gathered together at certain times, in order that the larvæ of the Œstrus may be removed from them. Loiset, in particular, has given a good description of this cutaneous malady of the Horse, from which it appears that, so far as external appearances go, the tumours produced by the Hypoderma resemble in every way those of the Ox. 'The Œstrus cuticole of the Horse is common,' he says, 'not only in the North of France, but also throughout Belgium, Holland, and the whole extent of the littoral of the Baltic and North Sea; for I have very often found it in young animals from these regions.' Fleming has observed the larvæ in the cutaneous tumours of army remount horses in England.

The larva is vesiculate, fusiform, expanded in front, and terminating in a blunt point behind. Much smaller than that of the Ox, it is only about 9 to 10 mm. in length; its skin is thin and diaphanous, and destitute of spines; its segments are very marked. The mouth is altogether unarmed (Loiset).

Joly, by reason of these particular characters, looks upon it as a distinct species, which he designates *Hypoderma equi*. Brauer, however, is inclined to think it is identical with the *H. Silenus*. But the question is still undecided, as it has not yet been possible to ascertain the nymphosis of these larvæ, nor yet has the perfect insect been found.

The tumours caused by the Hypoderma give rise, in the Horse, to the same inconvenience as in the Ox; in addition, they prevent the use of harness on the invaded parts of the body.

The preventive and curative treatment is similar to that for the Ox.

The larvæ of the Hypoderma have also been found beneath the skin of the Ass; but Brauer considers that they belong to his *Hypoderma Silenus*.

Dermatobia.—The *Dermatobia* (Brauer) can be distinguished by the proboscis, which is bent at its base, concealed in the buccal cavity, beneath the inferior surface of the head, and by the stylus of the antennæ, which is plumose at its superior border. The genus is interesting, for the reason that Man is sometimes the host of the larvæ of one species—the noxious Dermatobia (*D. noxialis* Goudot), which lives in America, from Mexico to Brazil. For it would certainly appear that it is to this Dermatobia that must be allotted not only the larva which according to Goudot, is known in New Grenada as the *Nuche* or *Gusano*, but also that which in Cayenne is named the *Macaw-fly*; in Brazil, *Ura*; at Costa Rica, *Torcel*; and in Mexico, *Moyoquil Worm*. It lives chiefly beneath the skin of the Ox and Dog.

It is elongated, terminates in a point, has spines on the borders of the segments in its anterior half only, carries two strong buccal hooklets, and measures about 3 cm. The perfect insect is about 17 mm. long, has the face and forehead yellow, with short, silky brown hairs; thorax brown, striped with gray;

abdomen flat, blue, and covered with small black hairs, their base being of a dull white.

According to Goudot, the *Dermatobia noxialis* is found in very great numbers on the borders of large woods and lands covered with underwood, so that such localities are regarded as unsuitable for herds of cattle. When they do chance to frequent them, it is observed that they pass the greater part of the day in sterile, sandy places, rather than venture to graze in the shade, where their enemies are so abundant. In certain years the larvæ of this fly are counted by hundreds on one animal. They occupy a large portion of the shoulders of Cattle, forming, by their agglomeration beneath the skin, a great collection of tumours, from which purulent matter is continually flowing through a multitude of openings. These orifices are frequented by other Diptera, which deposit their eggs in them, and in this way wounds are produced which sometimes are dangerous, and are always difficult to heal. The larvæ of the same Dermatobia are also located on the head, flanks, tail, and along the dorsal region; but their principal haunt is always on the shoulders, as this is the part where the animal can least defend itself by its horns, tongue, or tail.

In the countries where Dermatobia species are abundant, the hides of the slaughtered Cattle are frequently so perforated by holes as to be of little value.

Dogs are also very much attacked by these redoubtable Diptera, and often harbour a great number of larvæ; but Mules and Horses are exempt from their annoyance.

It is probable that the Dermatobia deposits its eggs in the same manner as the Hypoderma—that is, clandestinely and without pricking the skin. The agitation and dread the Cattle manifest, as Goudot has remarked, ought therefore to be ascribed to a special instinct or acquired experience of the effects of these Insects.

In America, in order to free Cattle from the larvæ of Dermatobia, measures are adopted similar to those employed in Europe against the Hypoderma. By methodical pressure, the larvæ can be expelled from the tumours, which are then dressed with salt water, removing at the same time all the eggs, which the Muscidæ never cease depositing. Not infrequently an animal which has been carefully attended to in the morning has, by the evening, in the openings made by the Dermatobia, a perfect swarm of small larvæ; these are destroyed by filling the holes with an infusion of tobacco, or, better, some Cevadilla powder.

It is not known to what species the Œstridæ belong which deposit their larvæ on the Oxen, Buffaloes and Gazelles of South and Central Africa.

According to P. Dutrieux, the natives of Unyamouezi, Central Africa, designate by the name of *founsa ia ngômbe*—that is, the 'Cattle-worm'—a larva which is developed beneath the skin of the Ox and Man, and which produces a kind of furunculous eruption; this larva is deposited in the egg stage by a large Fly that usually accompanies the Cattle. It appears to be unknown between the central plateau, or the Ugogo, and the east coast.

With regard to these subcutaneous larvæ of Africa, there is an interesting peculiarity. Certain birds of the order Passeres, allied to the starling tribe, and belonging for this reason to a genus named the *Buphaga*, or Beef-eaters (βοῦς, an Ox; φάγω, to eat), constantly accompany herds of ruminants, and when they see the tumours of the Œstri on their skins, they fix themselves upon the backs of these animals, and with their bill (which is fashioned like a pair of scissors) they dig and squeeze out the larvæ that lie beneath the tough skin, finally extracting them. The Cattle and Buffaloes willingly endure this operation, as if they appreciated its utility.

CHAPTER III

THE FLEAS

UNDER this well-known name are comprised the Insects designated in zoology as *Suctorians*, or, better, *Aphaniptera*. As has been already mentioned, the majority of naturalists are agreed to consider them as a sub-order of Diptera.

These are jumping Insects, whose metamorphoses are complete, and whose buccal apparatus is arranged, in the larvæ, for mastication, and for suction in the adults.

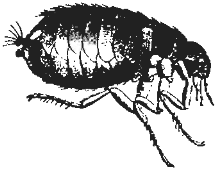

FIG. 18.—The Human Flea, male.

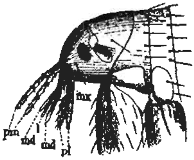

FIG. 19.—Head of the Human Flea, magnified thirty diameters.*

* *md*, mandible ; *mx*, jaws ; *pm*, maxillary palps ; *l*, single stylet ; *pl*, labial palps.—Railliet.

The latter have the body flattened laterally. The head is small, and round or angular, being widely joined to the prothorax. The rostrum—adapted for piercing the skin and sucking the blood—comprises (Fig. 19) : (1) two mandibles transformed into setiform prickers, and serrated ; (2) two jaws or triangular maxillæ, sharp, and each carrying at its base a long and thin palp of four articles ; (3) a single and rigid tongue ; (4) a lower lip, terminating in two palps of several articles, which serves as a sheath or support to the other parts ; there is no upper lip. The faceted eyes are replaced by two ocelli, which are sometimes rudimentary or are absent, behind which are concealed in a depression the antennæ, made up of from three to six articles. The three segments of the thorax are distinct ; the two last have small appendages in the form of plates, which represent the four wings. The abdomen comprises nine segments, overlapping at the sides. The legs are long, and adapted for jumping, principally the third pair ; the thighs and tibiæ are voluminous ; the tarsi are composed of five pieces, and terminate in two hooklets. The general colour is brown, and the length of the body—which is greater in the female than the male—varies from 1 to 4 mm.

The Fleas live as parasites on the Mammalia and on Birds, obtaining nourishment from their blood. Very agile, and capable of jumping extensively, these creatures pass readily from one animal to another, and all the more so as they often quit their host—voluntarily or accidentally—and wander on the floors of habitations. The female lays about twenty eggs in dusty, damp, and dirty corners, in chinks of floors, filth, sawdust, etc. According to Fürstenberg, the female Flea of the Dog ascends to the summit of the hairs, and turning its posterior extremity outwards, drops on the ground white, elliptical, elongated eggs, measuring 0·8 mm. long. Austin has observed that sometimes the Flea undergoes all the phases of its development on its host.

The hatching of the eggs occupies about six days in warm weather, and from nine to twelve days when the temperature is lower. From the egg comes a white, cylindrical larva, complete, and formed of thirteen segments (Fig. 20).

It is absolutely destitute of legs, and moves somewhat rapidly by crawling, which is favoured by two hooked points situated at the caudal extremity, and by long hairs directed backwards, which garnish the inferior and posterior border of the first twelve segments. The head, which is distinct from the body, independently of the buccal pieces has two antennæ, each composed of three short articles; and at the base of the lower lip are two small rounded elevations, each of which is provided with four points curved backwards, which may also serve in progression.

FIG. 20.—Larva of the Flea of the Fowl, magnified twenty diameters.—Railliet.

Towards the eleventh day, the larva spins a little cocoon, gets rid of its old skin, and is transformed into a nymph that already shows three pairs of legs, and carries two small caudal pincer-like points if it is to be a male, only one point if a female. The nymph is at first white, but it gradually becomes darker, and towards the eleventh to the twentieth day—depending upon the warmth of the season—it appears as the perfect insect, and immediately goes in quest of a host to torment.

Of the domesticated animals, the Dog, Cat, Rabbit, and Pigeons and Fowls, only have Fleas. It is more especially young, weakly, or confined Dogs—such as those which are chained up or suckling—that are invaded by Fleas, as they live in a condition favourable to the breeding of these insects—from egg-laying to their full development—which is more particularly favoured by litter and floors. Fleas can exist for a long time away from their habitual host; for they are sometimes found swarming in uninhabited places, in unoccupied Dog-kennels, and in abandoned Fox-holes. A remarkable maternal instinct has been attributed to them, as it is stated that they feed their larvæ on dried blood-corpuscles, which they carry to them. But attentive observation has proved that, in this respect, Fleas are absolutely indifferent to their progeny.

The species that live on Man and the domesticated animals belong to the genus *Pulex* (Linn.), which corresponds to the description given above. The best known is that of Man, the **Pulex Irritans** (Linn.) (Figs. 18, 19).

The body is oval, of a maroon-brown colour, and shining; the head, rounded above and in front, is destitute of spinules at its anterior border; it is the same with the posterior border of the prothorax. The length of the female is 3 to 4 mm.; that of the male 2 to 2·5 mm.

It can be conveyed to Dogs and Cats which live in contact with Man.

Two species live on the domesticated Mammals. One is the **Dog Flea** (*Pulex serraticeps* Gervais), which abounds on Dogs, is much less frequent on Cats, and may be transported to Man, though it rarely pricks him.

It is readily recognised, under a low magnifying power, by its blunt, black spines ranged like the teeth of a comb, which—seven to nine in number—garnish the inferior border of each side of the head, that is rounded in front.

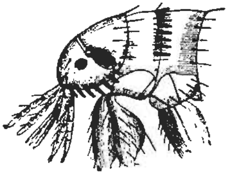

FIG. 21.—Head of the Dog Flea, magnified thirty diameters.—Railliet.

FIG. 22.—Head of the Flea of the Leporidæ, magnified thirty diameters.—Railliet.

The posterior border of the prothorax has also, laterally, seven to nine similar spines. The male is 2 mm. long, and the hinder part of the body is raised; the female is 3 mm. long, and the body is more rounded.

The other species is the **Flea of the Leporidæ** (*P. goniocephalus* O. Taschb.).

It is characterized by its head, the anterior summit of which is angular, and by the spines on the head and prothorax, which are only five or six on each side. The dimensions are sensibly the same.

It lives on Hares and Rabbits. On the Rabbit is also found the *Pulex serraticeps*, and sometimes also the *Pulex irritans*.

The Fleas which infest Fowls, Pigeons, and many other birds, are relegated by Taschenberg to a single species, the **Bird Flea** (*P. avium* O. Taschb.).

It has a somewhat elongated brown body; the head is rounded, and has no spinules at its posterior border, but the prothorax shows twelve or thirteen on each side of its posterior border. The male is 3 mm. long, the female 3·5 mm.

Fleas are often very troublesome, tormenting and harming animals by disturbing their rest and quietude. They are more frequently found on Dogs than on Cats, and they are common on Pigeons, rarer on Poultry.

The *Pulex serraticeps* infests more particularly sedentary Dogs and Cats—those which are nursing, and their young while sucklings; for laying the eggs and the development of the insect can then proceed under the most favourable conditions. 'The complete evolu-

tion of the parasite may even be accomplished on the body of its host. Austin mentions the case of a Dog which suffered for six months from a cutaneous irritation, accompanied by intense *pruritus, but without eruption. In the midst of the scurf* and epidermic scales he found eggs, empty shells, larvæ at different stages of growth, the remains of larvæ, nymphæ, and perfect insects. Leuckart has also found, in crusts from the eczematous *skin of a Dog, numerous larvæ* of Fleas, to which, in all likelihood, the eruption could not be attributed, but which had doubtless profited by this abundant source of nourishment.'—Railliet.

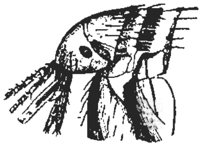

FIG. 23.—Head of the Flea of the Fowl, magnified thirty diameters.—Railliet.

A particular interest attaches to the Fleas, from the part they play as intermediate hosts for certain parasites in the course of transmigration. It will be shown hereafter that the *Dipylidium caninum* or *T. cucumerina* of the Dog lives in a cysticercoid state in the abdominal cavity of the Flea of that animal, and that certain embryos of Nematode worms which are often found in the blood of the Dog are ingested with blood by the Fleas, and develop in the intestine and abdominal cavity of these parasites. —See *Parasites of the Intestine*, and *Parasites of the Circulatory Apparatus*.

Destruction of Fleas.—There is no need to allude here to the Flea of Rabbits, nor yet to that of Cats, as these parasites are rare. To destroy those of Dogs, insecticide powders, which have for their basis the flowers of pyrethrum, stavesacre, or wormwood, are sprinkled over the animal so as to fall between the hairs; or the skin may be rubbed with common or laurel oil, with which a little powdered tobacco may be mixed, and a soap-bath given twelve hours afterwards. Some people are content to use benzinated, or, better, creolined water, or powdered parsley or wormwood. Cleanliness, baths, washing with potash or carbolic soap, prevent the multiplication of Fleas. Kennels, and other places invaded by these creatures, should be treated with boiling water or limewash. Pine-shavings have been recommended as bedding for Dogs, with a view to keeping away Fleas. It has also been recommended to have the floors of kennels made of the staves of old tar-barrels, laid edgeways between the stones. The persistent odour of the tar does not hurt the Dogs, and it drives away the Fleas. The same result is attained by sprinkling on the floor creolin powder or creolin water, 5 or 10 per cent.

For Poultry the same measures may be adopted, or those prescribed for Lice.

The Chigoe.—In Brazil, Guinea, Mexico (West Indies), in all the equatorial republics, and generally throughout the whole of tropical America, is found a species of Flea which is extremely redoubtable by the accidents that its

presence determines, principally in Man. Some years ago it was introduced into Africa (Congo, Gaboon) by ships arriving from Brazil, which disembarked it along with their merchandise, and it has already become a serious plague there.

It belongs to the genus **Sarcopsylla** (Westwood), which is characterized by peculiarities in the rostrum and its angular forehead, which has a number of small points resembling the teeth of a saw. It is known by the common names of **Jigger, Chigoe, Chiggre, Sand Flea, Penetrating Flea** (*Sarcopsylla penetrans* Wd., *Pulex penetrans* Linn.). It is much smaller than the ordinary Flea, the female—which is smaller than the male—measuring no more than 1·3 mm. long. Its colour is about the same as that of the Fleas of this country.

This insect lives in woods, on plants, dry herbage, and in sand, from which it passes to Man and the domesticated or wild animals, attaching itself principally to the limbs. It attacks Sheep, Goats, Cattle, Horses, Mules, Asses, Cats, and especially Dogs, and, even more so, Pigs. The latter have been considered as greatly contributing to the propagation of the insect. This Flea differs, then, from the other Aphaniptera by its indifference to the host it invades.

The male and virgin female act like the species of the genus *Pulex*. But the fecundated female penetrates the skin of Man or an animal, lodging itself beneath the epidermis, and remaining there for six or seven days. After the second day, the second and third abdominal segments of the Chigoe increase in size, enlarging in every direction, and pushing the thorax forward, the other abdominal segments backward, and assuming the appearance of a vesicle, the size of a pea. This sac is filled with eggs, which may be more than a hundred in number. These are ovoid in shape, white, and 0·4 mm. long. When they are mature, the female is often expelled by the pressure of the tissues which it irritates, and lays its eggs external to the host.

The presence of the Chigoe entails local disorders of an inflammatory nature at first, then ulcerative. The wounds have a tendency to extend and become gangrenous, and in Man—whose feet are oftenest attacked—arthritis, necrosis of bones and tendons, fistulæ, and loss of phalanges and toes, are frequently witnessed. Animals have the same lesions, and it is not rare to see those which have lost toes, or even an entire extremity; others have the ears deformed by irregular cicatrices.

Fig. 24.—An engorged Chigoe magnified.—Karsten.

Another species—the **Chigoe** or **Sarcopsylla of Fowls** (*Sarcopsylla gallinacea* Westwood)—a neighbour of the American Chigoe, lives on the domesticated Fowl, fixing itself principally around the eyes and on the neck. It has as yet only been found in Ceylon by Moseley, during the voyage of the *Challenger*, and by Green at Colombo; it has been described by Westwood.

Treatment.—The measure to adopt against the Chigoe is its immediate extraction. This is accomplished by means of a needle, and demands all the more expertness if the parasite has been long embedded; for there is danger in perforating the ovigerous sac, which would allow the eggs to escape into the wound, and thus give rise to grave complications. In such unsuccessful cases, the wound is washed with pure or carbolized water, or even cauterized with nitrate of silver, or dressed with tincture of iodine. Even in successful cases cicatrization of the wound is relatively slow. When the Chigoes are very numerous, frictions with mercurial ointment, sulphur baths, applications of benzine, etc., have been beneficially employed.

With regard to prophylaxis, the American Indians rub themselves with acrid and very odorous tinctures, and infusions of the leaves of tobacco or arnatto. The negroes employ inunctions of almond-oil of the *Carapa-guianensis*; these inunctions are very useful for protecting the paws and ears of the domesticated animals.

The Alakurt.—Schimkewitsch has described a form of Flea which is allied to the Chigoe, and, like it, belongs to the Sarcopsylla, but which should be placed in a separate genus—the *Vermipsylla*. It is found in Turkestan, and is known to the Kirghiz by the name of *Alakurt*—that is, a versi-coloured Worm or Insect, because it is at first nearly black, but on becoming distended it is white, with stripes of various colours. Schimkewitsch has given it the specific name of *Vermipsylla Alakurt*.

The female alone is known. It measures 6 mm. in length when completely developed. The head is large, rounded behind and narrow in front; the fossette for the antennæ is situated nearly in the middle of the head; the eyes are somewhat large; the maxillæ are triangular, and in the form of acute-pointed lancets, not curved backwards. The fecundated females have the abdomen vermiform and articulated like the Chigoe. The thorax is dark-brown, as are the abdominal segments; but the latter, in a state of distension, are wide apart, and united by a milky-white membrane.

The Alakurt is met with in certain valleys and on particular mountains in Turkestan. 'It appears in the autumn, when the mountains begin to be covered with snow, and it abounds more particularly during the intense cold. It lives as a parasite on Horses, Sheep, Camels, and Oxen, and brings about considerable debility, which, in foals, may terminate in death.'

CHAPTER IV

PHTHIRIASES

THE general name of *Phthiriasis* (from φθερί, a louse) has been given to the cutaneous affection due to the presence of *Lice* on the skin. It is also named the *Pedicular disease* and *Lousiness*.

In its ordinary sense, the term *Louse* comprises all the apterous parasites which do not jump like Fleas, and only by accident quit their host.

With the exception of the Melophagus of the Sheep and some doubtful species, all belong to the sub-order of *Hemipterous parasites*, *Rhynchota*, or the *Pediculinæ* of Piaget.

These are small-sized—only a few millimetres in length—apterous insects, of a dull-white colour, and the mouth of which is adapted either for pricking or masticating. The head bears two simple eyes, or *ocelli*, often but little distinct; and two antennæ, composed of three, four, or five articles. The three thoracic segments are more or less confounded with each other. The abdomen is usually composed of nine segments. The legs are ordinarily short and strong; the tarsi are formed of two articles, the last of which has two nails, or hooklets, by which the insect can creep. The eggs, called *nits*, are pyriform, have an operculum at one end, and are fixed very solidly to the hairs or feathers by a glutinous substance. The young—which leave the eggs by the operculum—have quite the shape of the adults, and do not undergo any metamorphoses, though they only acquire their definitive colour and consistency after several moultings.

The male and female differ from each other, in the former being a little smaller than the latter, frequently by peculiarities in the antennæ, by the last abdominal segment being often divided in the female and rounded in the male, which has also, on the middle line, a copulating apparatus of a brownish colour, and digitiform or lancet-shaped.

The males are usually much less numerous than the females.

The Hemipterous parasites are divided into two families—the *Pediculidæ* and the *Ricinidæ*.

The *Pediculidæ*, or *Lice properly called*, have the mouth arranged as a sucker at the anterior border of the head; the tarsi always terminate in a single claw, with the exception of the *Hæmatomyzus*, which has two. The *Ricinidæ*, or *Mallophaga*, have the buccal apparatus formed for mastication; they are *pellivorous*—that is, they live on epidermic productions, hairs (*pilivorous*), or feathers (*pennivorous*); the pieces constituting the mouth are placed at the inferior surface of the head, and the tarsi terminate in one or two claws.

PEDICULIDÆ.—These have a movable proboscis, formed of the upper and lower lips, and armed in front with one or two verticilli of small spines. In this canal are four channels, arranged two and two, the juxtaposition of which form an internal tube, or sucker, narrower and longer than the canal. The insect projects this sucker beyond the sheath to bury it in the skin, and uses it to aspirate the blood. The hooklets, or spines of the sheath, fix the aspiratory apparatus, and so prevent access of air. The thorax is small, but usually larger and shorter than the head, and shows scarcely any traces of its division into three segments. The abdomen is generally elliptical in outline, and has its last segment rounded in the male, with an opening for the penis; in the female this segment is notched or bilobate, with two small terminal appendages.

All the known species live on the Mammalia. The Lice infesting Man—the head Louse (*Pediculus capitis*), body Louse (*Pediculus corporis*), and pubic Louse or Morpion (*Phthirius pubis*)—belong to this family: genera *Pediculus* and *Phthirius.* The species which are found on the domesticated animals are all included in the genus *Hæmatopinus* (Leach).

Hæmatopinus.—The species of this genus are not very distinct from the genus *Pediculus*, the species of which are comparatively few, and live, two on Man, and a third on a Monkey. The Hæmatopinus species are characterized by their head being inserted directly on the thorax, without any constriction

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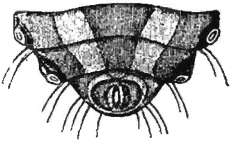

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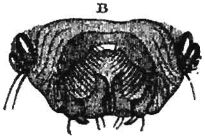


FIG. 25.—Magnified posterior extremity of the Hæmatopinus of the Pig.—Delafond.

A, Male dorsal surface. B, Female ventral surface.

like a neck; by their antennæ of five articles, their abdomen of eight or nine segments, their tarsi with a single claw, and their legs without a distinct appendage at the internal angle of their tarsal extremity (Figs. 25, 26, 28, 29, 34, 36, 37, 40).

They are found on all the domesticated Mammalia, with the exception of the Sheep, Cat, and Guinea-pig.

RICINIDÆ.—These parasites are often distinguished at first sight from the Pediculidæ by their head, which is always larger than their thorax, and the shape of which is determined by a system of dark horny *bands*, to which particular names are given. The most important are: 1. The *antennal bands*, which are marginal, and border the head in front, from the insertion of the antennæ, joining or not joining each other in the middle line; 2. The *occipital bands*, which extend—one on each side—from the occiput, or posterior border, to the base of the mandibles or orbit. The mouthpieces are situated on the inferior surface, and are principally constituted by the mandibles, in the form of short hooks, and by the jaws. The thorax generally has its *prothorax* distinct, but its other two segments are usually joined as one, which receives the name of *metathorax*. The first seven abdominal segments have their borders strengthened by a *lateral band*, and most frequently have transverse *spots*.

The masticatory apparatus of the Ricinidæ allows them to subsist on epidermic productions, and fragments of hairs or feathers. They do not suck the blood of their host like the Pediculidæ; so that they might be considered, not as true parasites, but as commensals which free the skin from its scurf. But it must not be concluded that they are really advantageous to the animal infested by them. Not only do they soil the skin by their dejections, their 'nits,' their exuviæ, and their dead bodies, but it is certain that their contact is felt by the creatures on which they live, and on which they produce disagreeable itching, accompanied by sharp biting. Birds invaded by these vermin are often in bad health.

The Ricinidæ are divided into two sub-families: 1. The *Philopterinæ*, which have the antennæ composed of three or five articles, and have no maxillary palps; 2. The *Liotheinæ*, whose antennæ have four articles, and are provided with quadri-articulated maxillary palps projecting beyond the anterior border of the head.

Philopterinæ.—Independently of the above characters, it is necessary to note in these parasites the frequently important development of the anterior part of the head, which is named the *clypeus*, and is sometimes distinctly separated from the posterior part by a suture. The *antennal sinus* is a more or less deep notch on each side of the middle line of the head, and at the bottom of it is a small protuberance that carries the antennæ.

The Philopterinæ are divided into eleven genera, only six of which are of interest here. These are: the *Trichodectes*, which live exclusively on Mammalia; the *Ornithobius*, *Lipeurus*, *Goniodes*, *Goniocotes*, and the *Docophorus*, which are parasitic on Birds.

Trichodectes (Nitzsch) are characterized by their three-articled antennæ, these having five in all the other genera. They are limited to Mammalia, the other genera being special to Birds (Figs. 27, 30, 31, 35, 38, 39).

Ornithobius (Denny), Fig. 49, and **Lipeurus** (Nitzsch), Fig. 46, have a narrow, elongated body, the sides being nearly parallel. The antennæ are different in the two sexes; besides, in *Lipeurus* the third article in the male has an appendage which is absent in *Ornithobius*. The latter has the abdomen bordered on each side by two parallel bands, while there is only one on *Lipeurus*. Ornithobius is special to the Swan.

Goniodes (Nitzsch.—Fig. 43) and **Goniocotes** (Burm—Figs. 44, 45) have the body flattened, sides rounded, or of an elongated oval, and the antennæ different in the two sexes, the first article in the male being larger than the others. In the male *Goniodes* the third article, and sometimes the first, has an appendage which is absent in *Goniocotes*; and the latter always has the abdomen rounded at the end, while in the male Goniodes it sometimes has two points.

Docophorus (Nitzsch—Fig. 48).—The antennæ are alike in both sexes, and are inserted in sinuses or excavations at the sides of the head, which has strong movable trabeculæ at its anterior angle.

The **Liotheinæ** are distinguished from the Philopterinæ by their four-articled antennæ and distinct maxillary palps. The head is very broad at the temples, and appears to be triangular or trilobate. In front of the temple there is often a notch, called the *orbital sinus*, in which is found the eye, though this is usually not very distinct.

The Liotheinæ comprise ten genera, four of which have their representatives on the domesticated animals. These are *Gyropus*, *Trinoton*, *Colpocephalum*, and *Menopon*.

The **Gyropes** (*Gyropus* Nitzsch—Figs. 41, 42) have only a single claw at the tarsi, while there are two in the nine other genera. The head presents, posteriorly, two notches, limiting the very salient temples. They are only met with on the Mammalia, and principally on Rodents.

The **Trinotons** (*Trinoton* Nitzsch) have the head very round in front, the temples salient and projected backwards ; a wide orbital sinus, having at the bottom a bilobate eye ; and the antennæ short and concealed. The thorax is divided into three distinct segments, and the tarsi have two claws. This species lives exclusively on Palmipeds.

The **Colpocephales** (*Colpocephalum* Nitzsch) have the head broader than long —somewhat like that of the Trinotons ; but they are distinguished from them by their rarely bilobate eyes, and antennæ projected beyond the head. The tarsi have two claws. They live on all kinds of birds except the Coursers.

The **Menopons** (*Menopon* Nitzsch—Fig. 47) generally have the head like that of the two preceding genera, but the orbital sinus is absent or very shallow at the part occupied by the eye, and often also that where the antennæ are fixed ; the latter are always short and indistinct. Living on Birds of all kinds except the Coursers, Piaget has on two occasions found them on Mammals—one of them, the *Menopon extraneum*, on the Guinea-pig.

This summary zoological description being considered sufficient to enable anyone to recognise the genus to which a parasite belongs, it will be easy to determine its species by the following information.

HORSE.—The horse harbours the *Hæmatopinus macrocephalus*, the *Trichodectes pilosus*, and the *Trichodectes pubescens*—the last less frequently than the first two.

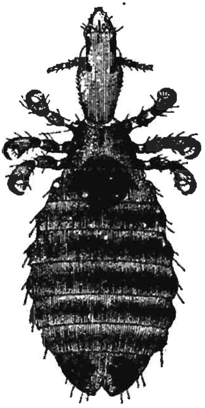


FIG. 26.—*Hæmatopinus macrocephalus*, female, of the Horse ; magnified twenty diameters.—Railliet.

FIG. 27.—*Trichodectes pilosus*, female, of the Horse ; magnified twenty diameters.—Railliet.

Hæmatopinus macrocephalus (Burm.—Fig. 26).—Head elongated and narrow ; antennæ implanted on a kind of lateral protuberance, behind which is a deep notch, lodging the eye at the bottom. At this part the temples are wide and curve forwards ; then the head contracts, and assumes a triangular form in its posterior moiety. The thorax is much shorter than the head ; the

abdomen is oval, with continuous and slightly sinuous borders; the two stigmata on the margin of each ring are placed in the middle of a lateral protuberance. The head and abdomen are of a grayish-yellow colour, and the thorax a brown maroon. The length of the female is 3·6 mm.; that of the male 2·6 mm.

Trichodectes pilosus (Giebel—Fig 27).—The head is broader than it is long, and is rounded in front—a little widened at the temples; the antennal band makes a turn around the forehead. The first seven segments of the abdomen have middle quadrangular spots. The head, thorax, legs, and abdomen are covered with hair on both surfaces, and, in addition, the last abdominal segment on the male has two hairy cushions. The general colour is yellow; spots and head ferruginous; band brown maroon. The length of the female is 1·9 mm.; that of the male 1·6 mm.

Trichodectes pubescens (*T. parumpilosus* Piaget).—This species is much rarer than the preceding; it is 0·2 mm. less in length, and differs chiefly in the head, which is hairy only along the borders.

ASS.—The *Hæmatopinus* of the Ass belongs to the same species as that of the Horse, but Piaget makes it a variety—*Colorata*—a

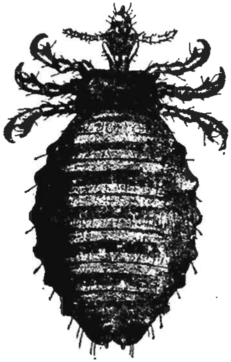


FIG. 28.—*Hæmatopinus eurysternus*, female, of the Ox; magnified twenty diameters.

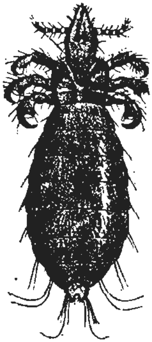


FIG. 29.—*Hæmatopinus vituli*, female, of the Ox; magnified twenty diameters.

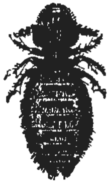


FIG. 30.—*Trichodectes scalaris*, female, of the Ox; magnified twenty diameters.—Railliet.

little larger than the type, head less hairy, tint darker, and with a quadrangular lateral spot on the sternum. *Trichodectes pilosus* is also a parasite of the Ass.

OX.—*Hæmatopinus eurysternus*, *H. vituli*, and *Trichodectes scalaris*, are found on the Ox.

Hæmatopinus eurysternus (Nitzsch—Fig. 28).—The head is rounded in front, slightly elongated—more in the male than the female. It is, besides, chiefly distinguished from the *H. macrocephalus* by its oval and very large abdomen, having on each segment a slightly-coloured lateral tubercle. The head and thorax are fawn-coloured, the latter being darkest; the abdomen is yellow or grayish; the genital spot is dark. The female is 3 mm. long, and the male 2 mm.

Hæmatopinus vituli—(Linn, Fig. 29, *H. tenuirostris*).—Rarer than the preceding, the head is elongated and somewhat buried in the thorax; the latter is as broad as it is long, and the abdomen is narrow—scarcely wider at the sixth segment—the largest—than at the first. The general tint is a deep chestnut, brighter on the forehead, legs, and the lateral band of the abdomen. The female is 3 mm., and the male 2·5 mm. long. It is found on sucking calves, and it also infests adults, perhaps as much as calves.

Trichodectes scalaris (*Nitzsch—Fig. 30*).—The head, scarcely so broad as it is long, is almost parabolic in shape, and very hairy. It resembles *Tr. pilosus*, but it has not the hairy cushions on the last abdominal segment, and the median spots are larger. The general colour is white, the spots ferruginous, the bands being darker. The length of the female is 1·5 mm.

SHEEP.—The *Pediculinæ* are only represented on the Sheep by the **Trichodectes sphærocephalus** (Nitzsch—Fig. 31).

It has the head as broad as long, rounded in front, the antennal band turning round the forehead, which has long hairs at the sides. The antennæ are hairy and slightly longer in the male than in the female; the median spots on the abdomen are sub-quadrangular. The general colour is white, spots and head ferruginous. The length of the female is 1·7 mm., and of the male 1·4 mm.

The phthiriasis of the Sheep is usually due to the **Melophagus ovinus** (Lat.), which belongs to the Pupiparous Diptera (see p. 33), but which, being apterous, does

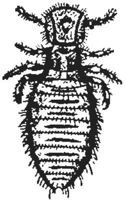


FIG. 31.—*Trichodectes sphærocephalus*, female, of the Sheep; magnified twenty diameters.

FIG. 32.—Melophagus of the Sheep; magnified. The line on the left indicates the natural length.

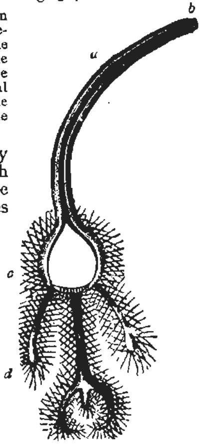


FIG. 33.—Proboscis of the Melophagus; much magnified.—L. Dufour.*

* *a*, Proboscis; *b*, its free extremity; *c*, basilar enlargement, with the muscles inserted into it; *d*, horny spines, also furnished with muscles.

Trichodectes latus (Nitzsch—Fig. 38).—The head is sub-quadrangular, much broader than it is long, truncated in front; the antennæ are hairy, and different in the two sexes, the first article in the male being much thicker, and occupying a moiety of the length of the organ. The abdomen is broad and more rounded in the female, with lateral, but no median spots. The colour is bright yellow, spots darker; the bands on the head are blackish-brown. Length of the female 1·5 mm., of the male 1·4 mm.

CAT.—The Cat has only one kind of Louse, the *Trichodectes subrostratus* (Nitzsch—Fig. 39).

Head sub-pentagonal, longer than it is wide, acuminated in front, with a small shallow notch; antennæ alike in the two sexes. Abdomen larger in the female and notched behind; in the male it has rather the shape of a horizontal cone, terminating in a very salient, conical, and downy ninth segment. Abdomen whitish; head and thorax bright-yellow, with the bands and spots darker. Length: *female* 1·3 mm., *male* 1·2 mm.

FERRET.—There is sometimes met with on the Ferret, and in great numbers, the *Hæmatopinus piliferus*, which lives on the Dog.

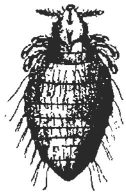


FIG. 40.—*Hæmatopinus ventricosus*, male, of the Rabbit; magnified twenty-five diameters.

FIG. 41.—*Gyropus gracilis*, female, of the Guinea-pig; magnified twenty-five diameters.

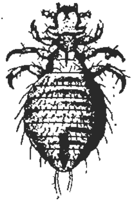


FIG. 42.—*Gyropus ovalis* male, of the Guinea-pig; magnified twenty-five diameters.

RABBIT.—The only Louse found on the Rabbit is the **Hæmatopinus ventricosus** (Denny—Fig. 40). It is rare.

The head is subuliform, broader than long, constricted behind the antennæ, widened at the temples, where it is rounded. The thorax is wider than the head, and is concave on the abdomen; the latter is oval, as broad as long, bulging, rough, and hairy. The head, thorax, and legs are of a bright chestnut colour; the abdomen is of a dirty-white. The length of the female is 1·3 mm., and of the male 1·2 mm.

GUINEA-PIG.—The Lice of the Guinea-pig are two species of *Gyropus* (Figs. 41, 42).

Gyropus gracilis (Nitzsch).—This is recognised by its long, narrow abdomen, especially in the male; by its head, made, as it were, trilobate in front of the antennæ; by the notch at the temples; and by its antennæ, the fourth article of which is globular, and rests on the third as an elongated peduncle. The general colour varies from dull white to ochre-yellow. The length of the female is 1·2 mm., and of the male 1 mm.

Gyropus ovalis (Giebel).—This differs by its large, oval abdomen, crenulated on the borders, and garnished with two rows of hairs on each segment. The head is shorter and broader. The general colour is white; the spots, tarsal bands, and claws are dark. It has the same length as *Gyropus gracilis*.

To these must be added the **Menopon extraneum** (Piag.), found once by Piaget, and of which mention has been already made (p. 61).

BIRDS maintain a larger number of Lice than the Mammalia, and these parasites all belong to the family of Ricinidæ. Each species is not strictly localized on a particular host, but many are common to several kinds of Birds. On the other hand, the promiscuousness of the poultry-yards, and, above all, of the markets, may lead to erratic parasites passing to a Fowl from a specifically different host.

FOWLS.—The parasites found on Fowls belong to the four genera Goniodes, Goniocotes, Lipeurus, and Menopon.

Goniodes dissimilis (Nitzsch—Fig. 43).—The head is broader than it is long and rounded in front; it is smaller in the male. The antennæ of the male—double those of the female—have the first article most developed, and have a long

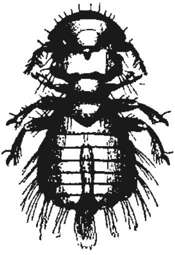


FIG. 43.—*Goniodes dissimilis*, male, of the Fowl; magnified twenty diameters.—Piaget.

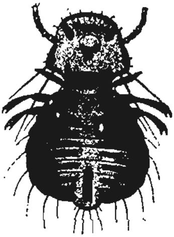


FIG. 44.—*Goniocotes hologaster*, male, of the Fowl; magnified forty diameters.

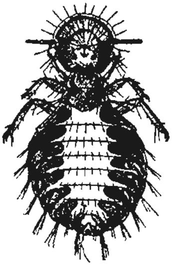


FIG. 45.—*Goniocotes gigas*, female, of the Fowl; magnified ten diameters.

hair at the inner side. The temporal angles are salient, especially in the female, but do not form horns. The antennal band is very strong, and wide in front, with a series of distinct fissures for the implantation of hairs. There are five bristles at the posterior border of the metathorax. There are also two median bristles, and three or four at the angles of each abdominal segment, with an arched marginal spot; at the ventral surface of the abdomen of the female there are two little bands in the form of a T laid sideways. The general colour is a dull white, the spots darker, and the bands fawn-tinted. The length of the female is 2·5 mm., and of the male 2 mm. This is one of the most frequent parasites.

Packard has observed on the Fowl a **Goniode of Burnett** (*Gd. Burnetti* Pk.), which is probably allied to *Goniodes dissimilis*.

Goniocotes hologaster (Nitzsch—Fig. 44).—The head is as wide as it is long, the anterior border rounded and slightly convex, the antennal band being wider in front. The abdomen has unicoloured quadrangular lateral bands, curved and broader towards the suture, and wider on the ventral than the dorsal surface; the transverse patches are faint, but distinct; the sutures are only visible between the first three segments. The general tint is a dirty-yellow, deeper at the thorax; the bands are brownish. The female is 1·3 mm., and the male 0·8 to 0·9 mm. long. Taschenberg has noticed a variety (var. *maculata*).

Goniocotes gigas (Tasch.—Fig. 45).—This is recognisable by its round and very large abdomen, marked on each segment by long, transverse, tongue-shaped spots, coloured only on their border. It has, besides, proportions which are quite exceptional in this genus. The general colour is yellow; the abdomen and metathorax are brighter coloured, and the bands and outline of the spots are dark. The female is 4 mm., and the male 3 mm. long.

Lipeurus variabilis (Nitzsch—Fig. 46).—The head is round in front, and is broadest at its anterior portion in the male, and at the temples in the female; it is margined in front by an uninterrupted antennal band. The first article of the male antennæ is longer than the other four put together, and has a strong obtuse excrescence. There is a middle spot beneath the thorax; the female has a genital, lance-shaped spot, and the last ring of the abdomen is bilobate. The general colour is a pale yellow, the spots being a deep fawn-tint, and the bands black. The female is 2·2 mm., and the male 1·9 mm. long.

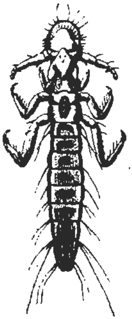


FIG. 46.—*Lipeurus variabilis*, male, of the Fowl; magnified twenty diameters.

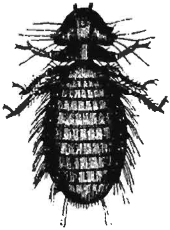


FIG. 47.—*Menopon pallidum*, female, of the Fowl; magnified twenty diameters.—Railliet.

Lipeurus heterographus (Nitzsch).—The head is parabolic in front, very wide behind the eye, and limited anteriorly by an uninterrupted antennal band. The metathorax is as long as the prothorax. The abdomen is an elongated oval, slightly larger in the female, with six short bristles implanted in tubercles on each segment in the male, and median spots on each ring and bristles on their borders. The general tint is pale yellow, spots fawn-coloured, bands black. The female is 2 mm. long, the male being 1·8 mm.

Menopon pallidum (Nitzsch—Fig. 47).—The head is slightly angular in front and somewhat crescent-shaped, the temples being bent downwards; the latter are short and rounded, with four bristles and some hairs; there is no appendage to the second article of the antennæ. The thorax is longer than the head in the female; they are equal in size in the male. The legs are strong and hairy. The abdomen is an elongated oval in the female, narrower and

longer in the male, with a single series of bristles on each segment. The general tint is a dirty-yellow, the spots on the abdomen being a bright fawn-colour. The female is 1·7 mm. long, and the male 1·8 mm.

Menopon biseriatum (Piaget).—This is rendered distinct from the preceding by its head, which is distinctly parabolic in front, by the presence of two series of bristles on each ring of the abdomen, and by the eighth segment, which is in the male elongated and narrow. It has the same tints as the preceding. The female is 2·7 mm. in length, the male 2·9 mm. This species lives also on the Turkey, Pheasant, and Pigeon.

TURKEY.—The parasites of the Turkey beloug to the genera Goniodes, Lipeurus, and Menopon.

Goniodes stylifer (Nitzsch).—The head is as broad as it is long; it is quadrangular, especially in the male; the temporal angle forms a long horn, acuminated behind and terminated by a bristle. The metathorax has divergent sides, acuminated on the abdomen, and bearing five bristles on the posterior border. The seven first segments of the abdomen show tongue-shaped spots on the sides, which cover the transverse third of the segment; in the middle of each there is a bright spot occupied by the stigma; there are numerous hairs on both surfaces. The general colour is dirty-white, the spots are fawn-coloured, and the bands brown or black. The length of the female is 3 mm., that of the male 3·2 mm.

Lipeurus polytrapezius (Nitzsch).—The head is relatively short—it is stronger in the female—scarcely so wide at the temples, and very rounded in front, where it is bordered by the uninterrupted antennal band. The first article of the male antennæ is thick, fusiform, a little longer than the other four collectively, and is provided with a strong excrescence at its base. Beneath the thorax there are two median spots, the second of which extends for a short distance on the abdomen. The female has an acuminated genital spot posteriorly, and the last abdominal segment is deeply notched. The general colour is yellow, spots fawn-tinted, and bands black. The length of the female is 3 mm. to 3·7 mm., and of the male 2·8 to 3·7 mm.

The **Menopon** of the Turkey is the *M. biseriatum*, which lives also on the Fowl. It is probably the same as the *M. stramineum* (Nitzsch).

GUINEA-FOWL.—A Goniode, a Goniocote, and a Menopon live on the Guinea-fowl.

Guinea-fowl Goniodes (*Gd. numidianus* Denny).—The head is longer than it is broad; the antennæ of the male are somewhat long, and have the third article curved and acute, carrying the succeeding two beyond its axis; the eye is salient, and occiput a little retreating. The metathorax is wider than the head and acuminated on the abdomen, with a black band at the posterior border; the legs are strong. The abdomen is oval, with the spots twice interrupted. Its length is 1·7 mm. It has been found by Denny on the Guinea-fowl.

There has also been found on this Bird the *Goniodes stylifer* of the Turkey.

Goniocotes rectangulatus (Nitzsch).—This differs from *Gonioc. hologaster* of the Fowl chiefly in the lateral bands of the abdomen, which are wide on the ventral surface of this parasite. The segmental sutures are only distinct between the three first. The length of the female is 1 mm., and of the male 0·8 mm. This species was found on a Guinea-fowl by Taschenberg, but it is rather a parasite of the Peacock.

Lipeurus of the Guinea-fowl (*L. numidæ* Denny).—The head is large, subpanduriform, rounded in front where it is bordered by the antennal band, and wide behind the eye; the female antennæ have the second article very long. The metathorax is nearly as wide as the prothorax. The abdomen is oval, the first seven segments showing a double series of spots, which form

two uninterrupted dorsal bands. The colour is livid yellow, and the bands and spots black. The length is 2·1 mm.

This species was found on the Guinea-fowl by Denny, who considered it a Nirmus (*Nirmus numidæ*)—he probably had not seen the female (Railliet).

Menopon of the Guinea-fowl (*M. numidæ* Gieb.).—The head is semilunar, and the orbital sinuses distinct. The prothorax is large, with three sharp points at each angle; the metathorax is large and trapeziform. The abdomen is also large, with festooned borders garnished with bristles and dark spots. The general colour is reddish. Length 1 mm.

PEACOCK.—The parasites of the Peacock, like those of the Guinea-fowl, belong to the genera Goniodes, Goniocotes, and Menopon.

Goniodes falcicornis (Nitzsch).—The head is nearly square, and curved somewhat downwards in front, especially in the male; the antennal band is narrow anteriorly and has parallel borders; the temples are angular, and do not form a horn behind; the occiput is scarcely depressed; the first article of the male antennæ is very thick, is nearly as long as the other four, and has a strong appendage on the inner side; the third article has a long curved appendage; the other two are thin, and rest on a protuberance of the third. The metathorax is not so large as the head in the female, but in the male it is as large, or larger, than the prothorax. The abdomen is very large, and on the sides has very dark-coloured languiform spots. The genital apparatus of the male is very large, and ascends to the third segment. The general colour is yellowish-white, the spots being a deep-fawn hue. The female is 3·3 mm., and the male 3 mm. long. This is a common parasite.

Small-headed Goniodes (*Gd. parviceps* Piaget).—This differs from the preceding principally in the head, which is more regularly quadrangular; in its metathorax, which is larger than the head; in its abdomen, which is scarcely so large as the metathorax; and in the dimensions of the male and female, which are 2 mm. long.

Goniocotes rectangulatus (Nitzsch).—This is the same as that which has been found on the Guinea-fowl.

Black-mouthed Menopon (*M. phæostomum* Nitzsch). — The head is elongated, contracted and rounded in front, very wide at its posterior border, and the temples narrowed and bent downwards. There is no appendage to the second article of the antennæ. The thorax is longer than the head, and the metathorax a little rounded on the abdomen; the latter is a long oval in the female and larger than in the male, with a single series of bristles on each ring. The general tint is yellow, brightest in the male; the spots are fawn-coloured. The female is 1·6 mm., and the male 1·3 mm. long.

PHEASANT.—The parasites of the common Pheasant are:

Goniodes Colchicus (Denny).—This differs from the *G. dissimilis* of the Fowl chiefly in the presence of a small tooth at the inner side of the antennæ of the male, of only two bristles at the posterior border of the metathorax, and in numerous median bristles on each segment. The dimensions are about the same.

Goniodes truncatus (Giebel).—The head is large and parabolically rounded in front; the temples are not excavated, nor prolonged posteriorly as horns; the occiput is convex, and the occipital angles are acute. The abdomen is an elongated oval, that of the male is truncated behind; the lateral bands are arched, and a short appendage on them is pushed into the preceding segment. The colour is white, with dark bands. The female is 3 mm., and the male 2·4 mm. long.

Goniocotes chrysocephalus (Giebel).—This differs chiefly from *Gc. rectangulatus* of the Guinea-fowl and Peacock, in having the sutures between the eight first segments of the abdomen visible. The colour is yellow, particularly on the head and thorax. The female is 1·2 mm., and the male 0·8 mm. long.

Lipeurus variabilis.—This parasite of the Fowl has also been found on the common Pheasant by Taschenberg and by Railliet.

Long Menopon (*M. productum* Piaget).—This differs from *M. pallidum* of the Fowl principally in having the temples less excavated, and the body elliptical and constricted to the sixth segment in the female, and nearly as short as broad in the male, with the ninth segment short and like a reversed ogive. The general tint ochre-yellow, fawn-coloured on the sides of the abdomen. The female is 1·8 mm., and the male 1·5 mm. long.

Menopon Biseriatum.—This is the same as that found on the Fowl and Turkey.

Among the parasites found on the Silver Pheasant, are placed the *Goniocotes chrysocephalus* of the common Pheasant, and a variety of the *Menopon phæostomum*, of which the type lives on the Peacock.

The Golden Pheasant offers, amongst others, the *Lipeurus heterographus* of the Fowl, and the *Menopon productum* of the common Pheasant.

PIGEON.—On the domestic Pigeon the following Recindiæ have been found:

Dwarf Goniode (*Gd. minor* Piaget).—All the species have the abdomen oval and broad, but this one is distinguished by the antennæ of the male, the last two articles of which are very reduced and scarcely visible; and by its metathorax, which is rounded on the abdomen. The colour is yellow, and the female is 1·7 mm. long, the male being 1·4 mm.

Companion Goniocote (*Gc. compar* Nitzsch).—The length of the head is a little less than its width at the posterior border; the anterior border is convex, and the antennal band linear. The abdomen is oval, and rounded in the female, truncated posteriorly in the male, and has coloured spots only on the border of each segment; each margin of the abdomen has two parallel bands. Colour, dirty-yellow. The female is 1·4 mm., and the male 1 mm. long.

Rod-shaped Lipeurus (*L. baculus* Nitzsch).—The head is elongated and very narrow, the anterior part—clypeus—being round and separated from the other portion by a constriction; it is not bordered in front by an antennal band, and is garnished by six fine hairs and two claviform appendages. The first article of the male antennæ is much thicker than the others, and has an enlargement at its base, but has no appendage; the third article has a strong lateral appendage. The prothorax is quadrangular, and one-third shorter than the metathorax. The colour is dirty-white, with bright yellow spots and brown bands. The female is 2·1 mm. to 2·3 mm., and the male 1·8 mm. to 2.3 mm. long.

Long-tailed Colpocephalus (*C. longicaudatus* Nitzsch).—The occipital bands are not distinct. The abdomen of the female is conical, and bordered by narrow dark bands; the first segments are the longest, the ninth elongated, constricted at its posterior moiety, rounded and fringed with long fine hairs; in the male the abdomen is an elongated oval, and the last segment is rounded and garnished with numerous long bristles. It is white, with fawn-coloured spots. The female is 1·6 mm., and the male 1·3 mm. long.

Broad Menopon (*M. latum* Piaget).—The head is parabolic, and nearly angular in front. There is an appendage to the second article of the antennæ in the two sexes. The thorax is longer than the head in the female, shorter in the male; the metathorax is not so broad as the head, and is rounded on the abdomen. The latter is large, oval, and rounded in the female, and oval and elongated in the male, with salient angles. The colour is yellow, with bright, fawn-coloured spots. The female is 8 mm., and the male 1·5 mm. long.

We have also found on a Pigeon the *M. biseriatum*, already described (p. 69).

GOOSE.—The parasites of the domestic Goose belong to the genera Docophorus, Lipeurus, and Trinoton.

Bilious Docophorus (*D. icterodes* Nitzsch).—The head is longer than broad; the clypeus is semicircular, with a triangle on each side, and at the lower surface a constricted elongated spot. The prothorax is not so wide as the metathorax. The abdomen is bordered on each side by a uniformly broad band; the first segment has an interrupted transverse band on the median line; the others have a wide lateral band, leaving free the middle third; the last is simply notched in the female. The colour is brownish-red. Length of female 1·8 mm., and male 1·3 mm. It is frequent on Ducks and relatively rare on Geese, on which it constitutes, according to Piaget, a mere variety that Nitzsch has named **Docophorus adustus.**

FIG. 48.—*Docophorus icterodes*, male, of the Duck; magnified twenty-five diameters.

Lipeurus jejunus (Nitzsch).—The head is elongated, and the clypeus is colourless, rounded, separated by a constriction and a suture, not bordered in front by an antennal band, and garnished by six fine and two spreading hairs at the suture. The prothorax is subtrapezoidal, and has a spot at the posterior angle, which projects laterally; the metathorax is twice as long, with a large tubercle at the posterior angle, on which are implanted four short bristles. The colour is dirty-white, spots dark fawn, and bands black. The female is 3 mm., and the male 2·5 mm. long.

Lipeurus anseris (Gurlt).—The head is elongated and conical, rounded in front, with the clypeus analogous to that of the preceding species. The metathorax is double the size of the prothorax, and is constricted at the sides. The colour is white, with black spots. The dimensions are the same.

Trinoton conspurcatum (Nitzsch).—This is a very large species. The head is as long as it is wide, and is exceeded in front by the last two articles of the palps, showing on each side two enlargements, the posterior of which—the temple—has five bristles. The thorax is longer than the head, and rounded on the abdomen. The legs are long, and garnished with hairs and bristles. The abdomen is oval, not so wide at the base as the metathorax, and the angles are salient; the first eight segments have a series of bristles fixed in colourless tubercles. The colour is white, the spots brown maroon, bands black, thorax dark, head bright-fawn tint. The female is 6·3 mm., and the male 5·8 mm. long. This parasite was found by Denny on the Goose, but it is more frequent on the Swan.

Trinoton continuum (Piaget).—This species has four bristles at the temples, the abdomen has slightly salient angles, and is more downy on its two surfaces, while there are fewer hairs on the legs. The dimensions are also less, being for the female 6 mm., and for the male 5·6 mm. long. It is, probably, only a variety of the preceding species, and is more common.

DUCK.—A Docophorus, Lipeurus, Trinoton, and a Menopon have been found upon the domestic Duck.

The **Docophorus icterodes,** described as infesting the Goose, is very common on the Duck.

Lipeurus squalidus (Nitzsch).—The head is narrow, elongated in front of the antennæ, and suddenly constricted at the suture of the clypeus; the latter has a spot—signature—parallel to the border, and rounded posteriorly. There are six hairs on the forehead, two of which are on the clypeus, the second being very flat; in front of the mandibles there is a round and small fossa; the temple is round, and has one bristle and a spine; the antennal bands stop at the suture of the clypeus, and do not go beyond it in front.

The metathorax is not so wide as the head, is slightly longer than it is broad, and is a little concave on the abdomen. The latter has a straight, uniformly wide, black band on each side; and transverse fawn-coloured spots more or less apparent. The general colour is fawn yellow. The female is 2·8 mm., and the male 2·5 mm. long.

This parasite is very common, and Taschenberg has found it on the Barbary Duck.

Pale Trinoton (**T.** *luridum* Nitzsch).—This more especially differs from the **T.** *conspurcatum* of the Goose, by the presence of only four bristles at the temples; the metathorax is concave on the abdomen, the latter having segments rounded at the sides; narrow transverse spots, interrupted in the middle on the first two segments, and surrounding a colourless circle on the side; and the bristles not having a swollen base. The colour is white, with maroon spots and black bands. The length of the female is 5·4 mm., and of the male 4·7 mm.

Dark Menopon (*M. obscurum* Piaget).—The head is crescent-shaped and strong, with the temples broad and turned downwards, and the lateral borders nearly as long as the thorax. The abdomen has dark, narrow, lateral bands without appendages. The colour is dark fawn. The length is 1·4 mm. to 1·5 mm. Common.

SWAN.—Independently of the *Trinoton conspurcatum*, which lives on the Goose, the domestic Swan—*Cygnus olor*—has an Ornithobius.

Ornithobius bucephalus (Giebel).—The head is massive, nearly as broad as it is long, irregularly quadrangular, and shaped anteriorly like a pair of closed forceps; the antennæ are strong and carried forward; the posterior part of the head is divided into three portions by the two occipital bands, which, at first parallel, converge in front towards the root of the mandibles. The thorax is narrower, and a little shorter than the head. The abdomen is oval, and nude except at the angles; the lateral bands are very narrow. The colour is white, with pearly transparent bands. The length of the two sexes is 3·5 mm. to 4·5 mm.

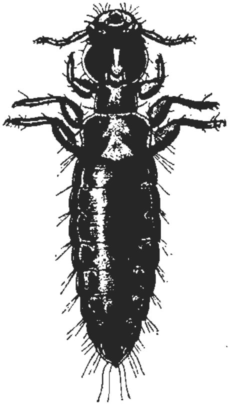


FIG. 49.—*Ornithobius bucephalus*, male, of the Swan; magnified fifteen diameters.

Symptoms.—Phthiriasis is manifested in all animals by signs of itching, the intensity of which is subordinate to the number of parasites, and the group to which these belong. The Hæmatopinus has the rostrum formed for pricking. It attacks the substance of the skin to feast on the blood and humours exuded as a result of this pricking, and causes a much more intense pruritus than that occasioned by Ricinidæ. The locality of the pruritus naturally indicates that of the parasites, which are also betrayed by their eggs—these being less deeply situated among the

hair or feathers—and likewise by the débris the parasites leave after moulting.

Horse and Ass.—The hæmatopinic phthiriasis of the Horse and Ass has its principal seat at the mane and forelock, but more especially at the root of the tail, or in the neighbourhood of these parts. The animal seeks to rub itself against everything within its reach, gently bites its neighbours, and allows itself to be bitten and rubbed by them. On entering a stable, it is easy to recognise animals so affected, by the erectness and matting of the hairs, especially at the root of the tail; and a careful examination will readily reveal the presence of the Hæmatopinus and its eggs, along with numerous epidermic pellicles—constituting a real pityriasis. When grooming has not been carried out for some days, the dried dead bodies of parasites, and the exuviæ of their moultings, increase the general aspect of uncleanliness. The papules which some authors have described are rarely observed, but only various excoriations due to rubbing. Railliet has seen an old mare 'which showed on the back little tumours caused by elevation of the epidermis, beneath which were numerous masses of Hæmatopinus.'

Trichodectic phthiriasis is less common, and not so pruriginous; but with this exception, it resembles the preceding, from which it is distinguished by examining the parasite. The Trichodectes are not often found on the upper parts of the body, but the two phthiriases may, though rarely, co-exist on the same Horse.

Ox.—The same symptomatic differences are remarked between the hæmatopinic and trichodectic phthiriases of the Ox; but, contrary to what is observed in the Horse, the latter appears to be the more frequent. The Trichodectes are spread over the whole body, while the Hæmatopinus prefers the ears, back of the head, upper border of the neck, and middle of the back and loins. The pruritus impels the animal to rub itself against trees, posts, or salient parts of its dwelling, and with its rough tongue it licks the skin; consequently, there are large hairless patches, and often an abundant epidermic secretion with—though very exceptionally—thickening of the skin, which may mislead as to the true nature of the malady.

Sheep.—The Sheep Lice are concealed at the bottom of the fleece. The presence of the Melophagus is indicated by the pupæ, which are attached to the individual fibres, and appear as shining oval bodies, not unlike small apple pips in colour and shape. In separating the wool, the parasites are found close to the skin, and when they are numerous the fleece is entangled, and sometimes absent in places. These parasites attract the attention of Starlings and Wagtails, which hover about flocks of Sheep, and perch familiarly on their backs in order to feed on the parasites.

The Melophagus often emigrates from suckling ewes to the lambs, which it sometimes torments so much as to cause serious emaciation. If the fleece is short, in order to avoid the teeth of the animal, the parasite takes refuge in front of the shoulders, on the

neck, and particularly about the ears and horns. By their biting they produce great itching, which makes the Sheep gnaw themselves, scratch their bodies with their hind-feet, and rub against anything within reach. At the places where the parasites have been biting, on separating the wool, a red patch the size of a lentil is seen, in the centre of which is a darker red spot.

FIG. 50.—Pupa of the Melophagus of the Sheep, attached to the end of a lock of wool.

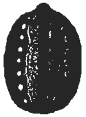


FIG. 51.—Magnified pupa of the Sheep Melophagus, seen on its dorsal surface, and showing two series of seven umbilicated points.

The Trichodectes are less frequently observed than the Melophagus, perhaps because of their smaller size. They may in certain cases seriously alter the wool; for its shedding appears to be due to the cutting they effect by their mandibles at the root of the fibres, according to the observations of Railliet.

The Trichodectes induce severe itching, and the wool is more or less altered, broken, and matted in places. There also may be seen bright-red spots from 8 mm. to 10 mm. in diameter, covered by thin furfuraceous scales, formed of epidermic débris and dried serosity. The Trichodectes are easily found, hanging on by means of their claws or jaws to the wool fibres on and around these places. According to Delafond, these parasites are much more common on lean, debilitated, or badly-nourished Sheep than on vigorous and well-fed ones.

Pig.—This animal is greatly incommoded when invaded by the Hæmatopinus. The species infesting it is the largest of the family, and causes a pruritus proportionate to its size. The skin is marked by red papules of various dimensions, and is often excoriated. The itching is most severe at night, and the animal rubs itself eagerly against its sty or trough, rolls in the litter, or even demolishes its habitation. Sequens relates that of 140 sucking-pigs, 40—aged from one to two weeks—succumbed to an intense phthiriasis affecting all the Pigs. The disease lasted four or five days. At the autopsies, besides signs of anæmia, there were found numerous excoriations and ulcerations on various parts of the body, the knees and hocks were inflamed, and even the capsular ligaments were involved—all the result of the intense pruritus which had destroyed these young Pigs. The disease ceased when parasiticide and disinfecting agents were had recourse to. Viborg was a witness to similar occurrences, which led him to declare that the Hæmatopinus may pass to beneath the skin, and make its exit by the nose, mouth, and eyes. This, so manifest an exaggeration, shows to what an extent these parasites may crowd on the same animal.

Dog.—Lousy Dogs do not appear to be much inconvenienced by their numerous parasites. Hæmatopinus torments them more than the Trichodectes, and sometimes to a high degree. Both are encountered on all parts of the body, but Hæmatopinus is more particularly seen about the throat.

Goat.—According to Delafond, Lice may live in very great numbers on the Goat, especially in winter. The skin becomes irritated, and the hair falls off, leaving bare places covered with flaky, sometimes thick crusts, beneath which the integument is red and frequently ulcerated. The Hæmatopinus more especially produces these troubles; but with Angora Goats the Trichodectes cause great depreciation in the value of the hair.

Camel, Cat, Ferret, Rabbit, and Guinea-pig.—The phthiriases of these animals have scarcely received any attention up to the present time, and their trifling importance or rarity justifies the silence maintained with regard to them. The Trichodectes of the Cat are seen most frequently on young animals debilitated by scabies. The majority of the Guinea-pigs affected have numerous Gyropus species concealed in their fur; their presence is revealed by a yellowish dust at the ends of the hairs twenty-four hours after the death of their host. The oval Gyropus is much less abundant than the small Gyropus, and prefers to localize itself on the head.

Birds.—Phthiriasis has a much greater importance for Poultry than for the domesticated Mammalia; as the first are nearly always attacked in a variable degree, and the multiplication of their parasites becomes a real nuisance, causing them to lose their rest, become emaciated, and frequently compromises the rearing of their offspring. Their parasites are found all over the body, though less on the thighs, neck, and head than on the trunk, and especially beneath the wings. It is sometimes the reverse, however; for it at times happens that the head, and chiefly the neck—which cannot be reached by the beak—are particularly frequented by the Lice. Each species of Fowl being capable of nourishing several kinds of parasites, these may be found collectively on the same individual. And as several of the Ricinidæ attack very different species, it may be remarked that, by the cohabitation of Fowls, Turkeys, Guinea-fowls, etc., one kind of parasite may be accidentally met with on an illegitimate host.

Diagnosis.—The diagnosis of the disease is easy, when the size of the parasites is known. It is well, nevertheless, so far as the Mammalia—and especially the Horse and Sheep—are concerned, to be careful not to attribute to Lice affections of the skin which are sometimes coincident with phthiriasis, but are of quite another nature. Such is scabies, which has otherwise a serious gravity, and which has been occasionally overlooked for some time, because the pruritus—of psoric origin—was ascribed to Lice.

Prognosis.—This is rarely serious, considering the efficaciousness of the numerous remedies we possess. Nevertheless, in certain

cases the malady induced is particularly obstinate to cure, especially when large numbers of young or debilitated animals have to be dealt with. Budelot relates the history of one enzoöty of hæmatopinic phthiriasis, affecting 119 Horses of a regiment of Artillery, which prevailed for nearly five months, notwithstanding the parasiticide treatment employed. It is true that, in reading this account, and in estimating the gravity of the cutaneous troubles he observed, one is inclined to question whether it was not one of those coincidences of scabies and phthiriasis the possibility of which has already been referred to.

The troublesomeness of phthiriasis is dependent upon the pruritus which accompanies it. It may happen—at least with cattle—that the loss of hair will temporarily depreciate the value of the animals. Such depilation is damaging to Sheep; the disease has been known to persist for six years in one flock, and the wool to fall off to such an extent that the animals looked as if just clipped.

Birds, and especially Pigeons, sometimes suffer much from the invasion of parasites. There are poultry-yards and dovecots where these insects are perpetuated, in spite of all the efforts made to destroy them. Young creatures, particularly young Pigeons, at times succumb to phthiriasis, and breeding is then rendered very risky. When the nests are infested with parasites, the Pigeons neglect hatching, and even abandon their young.

Etiology.—It is clear that contagion is the primary cause of phthiriasis, and that the rapid increase of Lice is due to a succession of prosperous generations, arising from a contagiferous host of the same species as that now dealt with.

It is always possible that two domesticated animals of different species may infect each other—as when the same kind of parasite may live on one or the other, as is the case with the *Trichodectes pilosus* of the Horse and Ass, with the *Menopon biseriatum* of the Fowl, Turkey, and Pheasant, with the *Goniocotes rectangulatus* of the Guinea-fowl and Peacock, with the *Docophorus icterodes* of the Goose and Duck, and with the *Trinoton conspurcatum* of the Goose and Swan. Beyond these exceptions, the parasites which accidentally venture upon a different species to that of their natural host do not become acclimatized or multiply there, but soon emigrate.

Certain conditions favour the extension of the malady, and give to the contagion an unusual activity.

Want of cleanliness plays the chief part in this extension. The length of the hair or the abundance of the fleece is one of the predisposing circumstances. In addition, debility in the animals gives a more favourable soil for the parasites, whether this weakness be due to age, breed, temperament, work, food, etc.

For example, the Trichodectes appear somewhat more frequently on young Horses, while the Hæmatopinus rather favours old ones. Calves are more exposed to Lice than adult cattle, and these parasites are rarely found on short-haired dogs, while they are frequent on

those with long frizzly hair. Though two species may live together, the *Hæmatopinus piliferus* is more particularly met with on long-haired sporting Dogs, as Spaniels, etc., and the *Trichodectes latus* on little Lap-dogs with long or frizzly coats, as small Spaniels, King Charles Spaniels, long-haired Terriers, Havana Dogs, etc.

Anæmic Sheep are frequently lousy, and in the instance cited by Railliet the nursing ewes were more especially attacked. According to Villeroy, ewes suffer most from the Trichodectes, etc., during the winter, and particularly if it be wet. It is stated, so Stephen asserts, that if lean Sheep are bought to feed on turnips, it is when they commence to fatten that the Melophagus multiplies on them in an astonishing manner. Otherwise it appears to prefer lambs, and on shearing they are sometimes found to be literally covered with the parasite in places at the anterior part of the neck.

The Melophagus species are at times so abundant that they constitute a veritable scourge; this happens in North America and in Iceland. And yet these parasites are not prolific, for the female only lays one larva at a time, and there are but four or five in the course of the year. These larvæ are sacciform, non-segmented, have four lateral surfaces, and measure 3·7 mm. long, 1·9 mm. broad, and 1·6 mm. high. Their buccal parts are alone movable. They become transformed very rapidly into nymphæ, even on the body of their host.

When the conditions are favourable Lice multiply, on the contrary, at a wonderful rate, the females being very prolific, and growth very rapid. It has been already stated that the third generation of a Louse of the human head amounts in about twelve weeks to about 125,000 individuals, and these calculations do not take into account the numerous causes of destruction which restrain this multiplication; they are, nevertheless, instructive in enabling us to understand cases of excessive phthiriasis.

When phthiriasis occurs among Poultry, it is ascribed to feeble nutrition, due to bad or too uniform food, to the influence of damp, dirty, close, dark, and badly-ventilated premises. There are years which are favourable to this disease, and seasons appear to have an influence on its progress, while temperament and breed are not to be ignored. Bechstein, cited by Rivolta and Delprato, states that of two Capuchin Monkeys living in the same conditions, one was infested with Lice, while they were rare on the other. We have observed the same occurrence in a Bantam Fowl, which was really lousy, while two Gascony Fowls living with it were quite free from parasites.

Treatment.—The attention required to be given to animals in cases of phthiriasis, will vary according to whether they are Mammals or Birds.

Mammals.—Perfect cleanliness keeps animals clear of lice. Such cleanliness is easy to realize with short-haired animals, and will rapidly get rid of the few parasites which contagion may convey to them. When phthiriasis is present, a cure will be singularly

favoured by removing the hair of the Horse or Ox, as well as of the long-haired Dog, and the wool of the Sheep. With regard to the latter, clipping usually suffices to get rid of Melophagus; many of the parasites are cut by the shears, and those remaining on the skin are soon knocked off by the animal rubbing itself, so that in about two days none are to be seen. Sometimes, however, for them as for other parasites, it is necessary to have recourse to insecticide agents, the number of which is considerable.

A. One of the most efficacious and most employed is the decoction of tobacco (30 to 50 grammes to the litre of water). When near a manufactory of tobacco, the expense is much reduced by obtaining the refuse powder, or the juice, to which ten times the weight of oil is to be added; though this juice, being rich in ammoniacal matters, has the inconvenience of decomposing rapidly. This treatment answers for all animals. Nevertheless, precautions must be taken; for the whole body should not be dressed at once, as poisoning may ensue from absorption of the alkaloids of the tobacco. For Sheep the preparation is kept in a bottle, the cork in which is perforated by a quill. As soon as the shepherd observes a Sheep commencing to scratch itself, he gets hold of it, and seizing its head between his legs, he opens out the wool and pours the fluid on to those places that require it.

B. Frictions with *fatty bodies*, linseed-oil in particular, kill the Lice by asphyxia. Cooking-oil, in which fish have been fried, has been recommended as especially efficacious. This treatment is more particularly applicable to the Pig.

C. Mercurial ointment is a certain cure, but its employment is dangerous; therefore only a small surface should be dressed with it at a time, and it ought not to be used for Dogs, even when they are muzzled, and still less for cattle, which are so sensitive to mercury. Numerous cases of poisoning of animals by means of mercury are recorded.

D. Frictions with a decoction of stavesacre seeds, 50 grammes to the litre of water, or of colchicum bulb in the same proportions.

E. Insecticide powder. It is well, beforehand, to damp the skin with soapy water. Then the powder is dusted or blown over the skin *ad hoc*. The powders of pyrethrum flowers, and stavesacre and cevadilla seeds are most generally used.

F. Frictions with a mixture of 1 part benzine, 6 parts of green soap, and 20 parts water; or, better, petroleum 1 part, common oil 10 parts. Employed alone, the benzine, and especially the petroleum, is too active, and may remove the hair.

G. Schleg's mixture is recommended in Germany, because of its efficaciousness and harmlessness. It is composed of 16 grammes each of arsenious acid and potash, and 1½ litres of water, to which 1½ litres of vinegar are subsequently added.

H. Cresyl, or creolin—1 to 5 per cent. aqueous solution—promises to take an important place in the treatment of phthiriasis. It is convenient and effective.

Whatever may be the remedy adopted, it is well to repeat the dressing at intervals of five to eight days, in order to kill the parasites hatched from the eggs, which have resisted the first dressing. The majority of the eggs are killed by vinegar, and this is the reason why it is so often added to parasiticide decoctions in the proportion of 500 grammes to the litre.

For house Dogs, fatty preparations, and in general all those which are likely to soil furniture or the hair, are to be avoided. For them, frequent baths, and washing with creolin solution and carbolized soap, are to be recommended, together with the use of insect-powder and the comb and brush.

Lastly, when a number of animals are invaded, independently of the curative measures, disinfection of the buildings—stables, sheepfolds, pigsties, kennels, etc.—is necessary. Boiling water at first, afterwards limewash, or merely creolin solution—5 per cent.—answers very well. All litter should be destroyed, and the animals should be dressed out of doors if possible.

Birds.—There are many ways of destroying vermin on Fowls. Flowers of sulphur, or one of the insecticide powders mentioned above, may be blown among the feathers by an instrument *ad hoc.* As the Fowls in flapping their wings, or the Pigeons in their flight, may shake out the powder, it is a good plan to moisten the roots of their feathers with glycerine or soapy water before blowing in the powder of pyrethrum or stavesacre.

But individual treatment will not suffice. The floors, ceilings, walls, perches, and nests are the haunts of parasites, which will soon take the place of those that have been destroyed; and sometimes great difficulty may be experienced in finally abolishing them. Schneider speaks favourably of fumigations with sulphide of carbon. Small open phials filled with this liquid are placed in the hen-roost or dovecot, at those parts where they are not likely to be upset, and very quickly all the vermin are destroyed or expelled. This can be repeated whenever a new invasion is apprehended.

Lime-dust is indicated as a means as simple as it is infallible. In the absence of the Birds, two small handfuls of this is thrown against the roof and walls, so as to produce a cloud of dust. A portion falls into the nests and crevices, and the remainder reaches the ground. The vermin are killed, and in about two minutes the place is carefully swept out, and the sweepings placed on a fire.

The procedure which is the most recommended and employed is the following: All the masonry is lime-washed at least twice a year, and everything in the roost is taken out—spars, perches, nests, etc.—and steeped in water containing 5 grammes of carbolic acid to the litre of water. Then with a hand-pump or any similar instrument, throw the solution with force upon every part of the interior of the dwelling; this kills and washes down the insects. After emptying the hen-roost and closing all the apertures, a quantity of sulphur may be burned therein. The place should be kept shut

up for three days, then opened widely for twenty-four hours before allowing the Fowls into it. The Fowls themselves are advantageously protected against parasites by lime or sand-baths. To form these there should be made in the run, under some kind of shelter, a shallow square hole, which is to be filled with lime, fine sand, cinders, or light soil, with which powdered sulphur may be mixed. If the Birds are much troubled with vermin, insecticide powder may be added to this bath.

According to the *Hausfrauen Zeitung* (1889), instead of spreading straw on the floors of the roost, wood wool should be used, or wood chopped up into fine pieces, such as are used for packing. A layer of this is warmer than straw, drives away the vermin by its aromatic odour, does not rot so quickly, and furnishes an almost odourless manure very suitable for clayey, heavy soil.

For some time there has been sold an engine named 'Lagrange's Exterminator,' which serves to kill the parasites on the Birds themselves. This is a wooden box into which the Bird is introduced with its feet tied, its head being kept outside by a special opening. In the box sulphur or a brimstone match is burned, and five minutes of this fumigation suffices to kill all the parasites.

Lastly, it may be mentioned that there is another means, somewhat insufficient, but very often adopted, which consists in putting into the roosts a branch of alder-tree. The Lice, attracted by the odour, gather upon it, and early next morning the branch is carefully removed and burned outside. This is repeated until there are no parasites.

FIG. 52.—Bug of the Fowl.—Railliet.
A. Natural size. B. Magnified.

Independently of the parasites mentioned, and those to be alluded to hereafter, some Insects may accidentally torment Birds, and form part of their vermin.

The Fowl, and particularly the Gosling and Duckling, are sometimes attacked by small Diptera, which pass into their nostrils and ears. They may be protected by one of the remedies already noticed, or, better, by a decoction of walnut-leaves—30 grammes to the litre of water containing 125 grammes of vinegar; or of assafœtida—60 grammes to the same quantity of water and vinegar as in the preceding. With this the threatened parts should be impregnated.

In unclean roosts and dovecots there are sometimes large numbers of Bugs that belong to a particular species—the **Dove-cot Bug** (*Acanthia columbaria* Jenyns)—closely allied to the **Bed Bug** (*Acanthia lectularia* Linn.), which is well known. These Bugs exhaust young animals by sucking their blood, and fatigue them by the itching they induce after the bites. According to Railliet, hens hatching are so tormented by these parasites that they sometimes abandon their eggs, on which are then seen small specks formed by the excrement of the Bugs.

Pigeons also suffer from larvæ of the **Dermestes lardarius** (Linn.), the **Tenebrio molitor** (Linn.), and various **Necrophores** (*Necrophorus* Fabr.) and

Silphes (*Silpha* Fabr.). These larvæ of the Coleoptera, which are at first developed in old manure of the dovecot, finish by attacking the young Pigeons, gnawing the skin of the neck and abdomen—even the superficial muscles—and producing wounds which are often fatal, and in which burrow the larvæ of Muscidæ. This evil is closely allied to the uncleanliness of habitations, and should be remedied. Otherwise, these vermin can be made to disappear by the means already indicated: but in this particular case the floor of the dovecot should be covered with pine sawdust mixed with sand, some of this mixture being also put in the nests.

The attention to individuals consists in removing the larvæ from the wounds, and in dressing these with a 1 per cent. aqueous solution of carbolic acid.

CHAPTER V

ACARIASES

By the term *Acariasis* (Kirby and Spence) is understood every disease caused by Acarina. These form a separate order in the class Arachnida.

The *Acarina*—often designated *Acaridæ*—which were at one time named *Acari*, *Mites*, etc.—are generally creatures of small dimensions, with short, thick, non-articulated bodies, and having the head, thorax, and abdomen all in one mass. In some instances, however, the head and thorax are separated by a groove, and it may happen that the thorax is rendered distinct from the abdomen in the same way.

The chitinous integument usually shows very fine parallel ridges, and in places varied enlargements with bristles, hairs, prickers, etc., that may be collectively designated *trichoma* (from θρίξ, τριχός, hair).

The anterior portion of the cephalo-thorax has a depression named the *camerostoma*, because it lodges the buccal parts or *rostrum*, which is generally formed of distinct pieces arranged for biting or sucking, and comprising from above to below: a pair of *chelicerœ* or *mandibles*, a pair of jaws or *maxillæ*, each carrying on the sides a *maxillary palp* or *lower* lip. This rostrum projects beyond the camerostoma, or remains concealed beneath the *epistoma*—the upper wall of the camerostoma.

The four pairs of legs—composed of six, five, or even three articles only—have their base either inserted directly into the non-modified integument, or into its skeletal enlargements, which are designated *epimeræ*. They are terminated by hairs or claws, and have often, besides, a kind of vesicular lobe, or membranous caruncle, which, by its power of adhesion, singularly facilitates the progress of the Insect. In the majority of the parasitic species, these *ambulacra* are constituted by a small pedicellate sucker.

A large number of terrestrial or aquatic Acari have one or two pairs of stigmata—the external openings (tracheæ) of the respiratory apparatus—pierced in the tegumentary thickenings named *peritremes*. The stigmata are absent in the majority of permanent parasitic forms, in which the respiration is simply cutaneous.

The sexes are separate in all the Acarina. The males are less numerous than the females, and are distinguished from them by their smaller size, certain details in conformation, the presence of copulatory organs, etc. They also often lead a different kind of life, and have a different régime.

Amongst the males and females in the colonies of Acarina, there are found a larger or smaller number of individuals with no definite sexual characters. These are the *larvæ*, which are usually provided with only three pairs of legs (*hexapodal larvæ*). They undergo a succession of metamorphoses, one of which leaves them with a fourth pair of legs, and the creature is then termed a *nymph* (*nympha* or *pupa*). Another metamorphosis brings about the development of the genital organs, and the Acarus is now a *pubescent male* or *female* (or *imago*). Finally, a last transformation, proper to the female and consecutive to copulation, makes her an *ovigerous female*.

The majority of the Acarina are parasitic—either temporarily or permanently. Among the first there are some which are merely commensal, the presence of which is not accompanied by any particular disturbance, and which only require a host as a means of transport. Others live on epidermic débris and natural excretions of the skin; while others, again, prick the integument in order to suck the blood, or instal themselves in its superficial layers and determine cutaneous affections, which are sometimes very serious.

The order of Acarina contains a very great number of forms, and has been divided into families. We recognise ten, which we classify as follows:

- Non-vermiform Acarina.
  - Legs inserted directly into the integument, without epimeræ.
    - Legs with 5 articles - - - - - *Oribatidæ.*
    - Legs with 6 articles.
      - With tracheæ. Cheliceræ,
        - provided with hooklets - *Ixodidæ.*
        - didactylous or styliform - - *Gamasidæ*
      - With no tracheæ (marine Acarina) - - - - *Halacaridæ.*
  - Legs articulated on distinct epimeræ.
    - Natatorial legs (aquatic Acarina) - - *Hydrachnidæ.*
    - Ambulatory Legs.
      - Cheliceræ styliform; palps free, antenniform - - - - - *Bdellidæ.*
      - Cheliceræ styliform or in claws; palps free, ravishers - - - - *Trombidiidæ.*
      - Cheliceræ didactylous; palps cylindrical or conical, and partially adherent to the lips - *Sarcoptidæ.*
- Vermiform Acarina -
  - Legs with 5 articles - - - - *Phytoptidæ.*
  - Legs with 3 articles - - - - - - *Demodecidæ.*

Of these ten families, only five concern us: these are the *Ixodidæ*, *Gamasidæ*, *Trombidiidæ*, *Sarcoptidæ*, and *Demodecidæ*. Each of these may have representatives on the domesticated Mammalia or Birds, with the exception of the Demodecidæ, which, so far as is at present known, are only found on Mammals. The following are the principal characters of these five families:

1. **Ixodidæ.**—These are relatively voluminous Acarina, and are more or less flat when fasting, globular when replete. The rostrum (Figs. 53, 54) is composed of: 1, two elongated cheliceræ, terminating in a harpoon-like article with three or four teeth; 2, an undivided hypostome (*maxillolabial dart*), formed by fusion of the two maxillæ along with the inferior lip and tongue, the dart being furnished beneath, and sometimes on its sides, with several longitudinal rows of teeth, the points being retrograde; it has, laterally, two quadri-articulated cylindrical or flattened palps, or they may be channelled on their inner surface, so as to form for the dart, when brought

together, a bivalve sheath. The legs have six articles terminated by a sucker, formed of a caruncle plaited like a fan—except in the *Argasinæ*—and a pair of hooklets. The respiration is tracheal, the apparatus terminating in a pair of stigmata situated behind the coxæ of the fourth or of the fifth pair of legs, and protected by a discoid peritreme pierced like a sieve. Often two eyes. Orifice of the sexual organs—genital pore—in the form of a transverse slit, is situated between the coxæ of the two first pairs of legs, sometimes a little more behind. Oviparous.

2. **Gamasidæ.**—The integument is coriaceous, partially or wholly, and has two chitinous plastrons: a superior, dorsal, and an inferior, ventral, which give attachment to the legs. The rostrum is arranged for pricking or sucking: the chelicerae are generally disposed as didactylous pincers, and are usually dissimilar in the two sexes; the maxillæ are fused into a perfect tube on the upper surface by the labrum, which is festooned; the maxillary palps are simple, free, antennæ-like, composed of five articles, and provided inwardly with *galeæ* or secondary palps. The legs have six articles, terminating by two hooklets and a trilobate membranous caruncle. There are two stigmata situated near the posterior legs and protected by a very long tubular peritreme, lying along and above the haunches and opening in front. There are no eyes.

3. **Trombidiidæ.**—These are nearly always soft Acarina, more or less hairy, generally bright-coloured, their skeleton being composed of epimeræ. The rostrum is a conical sucker formed of a pair of hooked or styliform chelicerae, rarely as didactylous pincers, contained in the tube constituted by the joined maxillæ and the lower lip; the palps are more or less voluminous, and the second last article is frequently terminated by a hooklet, the last being fixed either at its base or, more rarely, at the middle part or summit. The legs have five or six articles, usually terminating in two hooks, and often accompanied by a cirrus or a small caruncle. The respiration is tracheal. There are often two eyes (Figs. 58, 59, 60).

4. **Sarcoptidæ.**—These are the smallest of the Acarina, their size being between 0·1 mm. and 1 mm. The body is soft, white or reddish, the integument being sustained by epimers. The rostrum is composed of two short didactylous chelicerae, gliding on a middle piece, spoon-shaped, and formed by the junction of the two jaws with the lip and tongue; the maxillary palps have three cylindrical articles. The legs have five articles disposed in two groups of two pairs each—one near the rostrum, the other near the abdomen. The tarsi are terminated by one or more hooklets, which are often accompanied by a campanulated sucker or a vesiculous caruncle. There is no respiratory apparatus, the respiration being cutaneous. There are no eyes. Oviparous or ovoviviparous.

5. **Demodecidæ.**—These are very small, vermiform, glabrous Acarina, the skeleton of which has epimeræ for its base. Their bodies are distinctly divided into cephalothorax and abdomen; the latter being conical and elongated. The legs are short, and have three articles: haunch, thigh and tarsus. Oviparous. There is only one genus—the *Demodex* (Owen).

The numerous species of parasites of the domesticated animals which these five families of Acarina contain, are far from producing the same degree of disturbance on or in the skin they inhabit. There are some which are merely commensals, living on the epidermic scales, and the remains of hairs and feathers. Others prick the skin in order to suck the blood, but their action does not extend beyond the points they attack. And a certain number, by their rapid increase, the multiciplicity of their bites, by the venom they implant, by the galleries they excavate, and by the deep situation in which they locate themselves, give rise to a disease which is generally grave—*mange, scabies*, or *psora*.

It is necessary, therefore, to distinguish between ***non-psoric***

Acariases and *psoric Acariases.* The latter are produced either by Acarina forming in the Sarcoptidæ a special tribe—the *psoric Sarcoptidæ* or *Sarcoptinæ*, or by the Demodex. The non-psoric Acariases are due to the Gamasidæ, the Trombidiidæ, the Ixodidæ, and the non-psoric Sarcoptidæ.

On the other hand, it is advantageous for study to consider separately the acariases of domestic Mammalia and those of Birds.

On these principles are established the following divisions, in which, under the term 'acariases' are passed in review all the Acarina—pathogenic or non-pathogenic—which live on the domesticated animals.

A.—ACARIASES OF THE DOMESTICATED MAMMALIA.

Article I.—Non-psoric Acariases.

These acariases will be studied here in the same order as the families which produce them: Ixodidæ, Gamasidæ, Trombidiidæ, and Sarcoptidæ.

I. **Ixodidæ.** — The Ixodidæ (see p. 84) are temporary parasites which may attack all the terrestrial vertebrata—Mammalia, Aves, Reptilia and Amphibia—but there is no constant correspondence between the species of host and that of the parasite; the female, nearly alone, shows a sort of specific preference, but the larvæ, the nymphæ and the males are often found on the most diverse animals, differing in orders, and even in classes. P. J. Beneden has included them in his group of 'free parasites in early age.' Most abundant in warm countries, the Ixodidæ are rare in polar climates, where the temperature is unfavourable to the requirements of hatching and of the young tick in early age.

As the parasitism of a species is not strictly limited to the presence of a definite vertebrate—the same species of Tick being found on various hosts—this indifference as to the host greatly increases the chances of dispersion of the parasite. Those which live by preference on Mammals or domestic birds are, owing mainly to the passive cosmopolitanism of the latter, frequently spread far from their country of origin. In this way certain species, as *Ixodes ricinus, I. hexagonus, Hyalomma Ægyptium, Rhipicephalus sanguineus, Rh. annulatus*, etc., are found in very different and distant countries.

The genus *Ixodes*, relatively poor in species, thrives well in temperate climates, and has representatives all over Europe, in North Africa, Asia, Australia, and America—even in the most northern parts of that continent. *Amblyomma* does not live in Europe. It is a genus of warm countries, and figures largely in South America and Africa, much less in Asia, and still less in Oceania. *Hyalomma* appears to be an African genus, though one species, *H. Ægyptium*, has been found in Asia Minor, Syria, India,

and in China at Pekin. Other species of *Hyalomma* have found their way to England, Mexico, Trinidad, and Brazil. *Hæmaphysalis* comprises few species, and these are found chiefly in Asia, Europe and in Africa, where *H. Leachi*, the carrier of the parasite of Canine Piroplasmoris, has a wide distribution. *Rhipicephalus* is especially African. In Europe it is only found in the south, and it is rare in Asia. In America and Australia it is represented, nearly exclusively, by *Rh. annulatus* and its varieties; but probably other species have been imported. *Aponomma* belongs to hot countries (Africa, Oceania, Asia), and one species has been found in Patagonia. *Dermacentor* has representatives in Europe, Asia, Africa, and America—North and South. *Ornithodoros* is only represented in Europe by *O. talaje*, variety *coniceps*, in Italy and Russia. One African species, *O. Savignyi*, is also found in India. The Asiatic species is *O. Tholozani*; and four distinct species are harboured by the hot countries of America.

Our knowledge of the habits of the Ixodidæ has been greatly extended since 1893, when Smith and Kilborne published the results of their investigation of the nature and causes of Texas Fever in American Cattle. These pioneers in the pathology of tick-borne diseases cleared the way for later workers, with the result that the various Piroplasmoses—bovine, ovine, equine, and canine, including Rhodesian Fever (Cattle), 'Heart-water' (Sheep and Goat), 'Rocky Mountain Fever' (Man), Carceag (Sheep), and Spirochæte disease of Poultry—are now well understood, and their treatment can be conducted on a rational basis.

The family of the **Ixodidæ** has been divided into two sub-families: *Ixodinæ* and *Argasinæ*, the first comprising seven genera and the second two, as under:

- *Ixodidæ*
  - *Ixodinæ*
    - *Ixodes*
    - *Rhipicephalus*
    - *Hyalomma*
    - *Amblyomma*
    - *Aponomma*
    - *Dermacentor*
    - *Hæmaphysalis*
  - *Argasinæ*
    - *Argas*
    - *Ornithodoros*

Ixodinæ.—Rostrum terminal—*i.e.*, inserted in an anterior depression of the cephalothorax. Palps valvate (the second and third articles forming a sort of gutter which can ensheath the hypostome and the chelicerae, the fourth short—in the form of an appendix at the inferior face of the third). Dorsal shield, small and anterior in the female, covering all the superior surface of the body in the male.

The *Ixodinæ* comprise seven genera as follows:

1. **Ixodes** (Latr.).—Has long palps; no eyes; an anal groove surrounding the anus in front. Plates on all the ventral surface of the male, which has the hypostome less denticulated and different from that of the female.

2. **Rhipicephalus** (Koch).—Palps short. Base of rostrum has salient lateral angles. Two eyes—prominent, glossy, situated on each side at the border of the dorsal shield on a level with the emergence of the second pair of legs. Anal groove surrounding the anus behind. Two elongated adanal plates in the male.

3. **Hyalomma** (Koch).—Palps long. Base of rostrum not salient laterally. In other features this genus resembles *Rhipicephalus*.

4. **Amblyomma** (Koch).—Palps long. Two eyes. Anal groove surrounding the anus behind. No ventral plates.

5. **Aponomma** (Neumann).—Palps long. No eyes. Anal groove surrounding the anus behind. No ventral plates. Body large.

6. **Dermacentor** (Koch).—Palps short. Eyes present. Anal groove surrounding the anus behind. No ventral plates; but the coxæ of the fourth pair of legs are very large in the male.

7. **Hæmaphysalis** (Koch).—Palps short, with the second article usually salient externally. No eyes. Anal groove surrounding the anus behind. No ventral plates.

The **Ixodinæ** are popularly known as *Ticks* and *Wood-mites*.

They have been recognised for a very long time, as Aristotle speaks of them as Κυνοραίστης, from which Hermann has derived the generic name *Cynorhæstes*, signifying 'the Dog tormentor.' For it is on Dogs—and particularly sporting Dogs—that these creatures are most frequently found, as they frequent woody places and go amongst underwood and low plants which the Ixodinæ prefer, and where they live in a vagabond condition. According to Latreille, the Ixodinæ maintain themselves suspended to plants by their anterior legs, ready to fall upon any animals which pass within their reach.

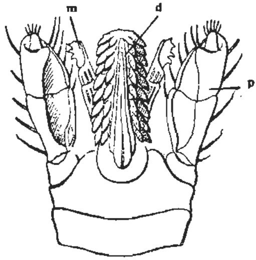


FIG. 53.—Rostrum of *Ixodes ricinus*, seen from below; magnified about fifty diameters.—Delafond.

m, cheliceræ; *p*, maxillary palps; *d*, maxillo-labial dart.

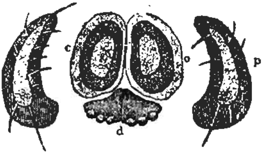


FIG. 54.—Transverse section of the rostrum of *Hyalomma Ægyptium*, magnified fifty diameters.

c, chelicerae enveloped in the sheath; *p*, maxillary palps; *d*, maxillo-labial dart.

Propagated more or less distant from their host, they thus attach themselves to him, either to be transported by him, as in the case of the larvæ and the males; to be nourished on the small quantity of pus produced at that point in the skin where their barbed rostrum is implanted, as happens with certain nymphæ and also

males; or to feed upon blood only, as occurs with the fecundated females.

In order to obtain this living nourishment, the Tick fastens itself firmly on the host with its legs, directs its rostrum perpendicularly towards the skin, and on the selected point thrusts in the terminal hooks of its chelicerae. In proportion as these penetrate, the dart follows, and the retrograde teeth on the under surface of this organ ensures the stability of the apparatus in the wound. In this way the dart is driven in as far as its base, while the maxillary palps remain external, and are applied to the skin on each side of the wound. The adherence of the rostrum in the derma is so intimate, that by violent traction on the tick there is risk of obtaining only its body, the buccal pieces being left in the wound. Otherwise, methodical removal of the parasite nearly always results in tearing away a small shred of skin fixed on the teeth of the dart, and held between the palps. The apparatus of aspiration consists of a thin membrane, expanded like a bell around the rostrum and the salient borders of the buccal cavity.

In gorging themselves with blood, the fecundated females acquire a considerable size—sometimes ten times their original volume; but some of this increase is due to the development of the enormous quantity of eggs which fill the uterus, and which render this intense alimentation necessary. When satiated, and having attained the size of an olive—and even of a nutmeg—the female withdraws her rostrum from the skin of the host, falls to the ground, and—concealed beneath some object, stones, leaves, or bark of trees—lays an immense number of eggs agglomerated in a heap, with which she remains for some time in contact. Hatching lasts from fifteen to twenty days. The female tick, now empty and shrivelled, and having resumed nearly her primitive volume, soon dies.

The hexapod larvæ that issue from the eggs are very small. They sally out on every side, and are often observed in the fur of wild rodents; they do not attach themselves by the rostrum, and they preserve their primary clear colour. They may live for months without nourishment, and it is probable that, with few exceptions, they effect their transformation into nymphæ on the ground. The nymphæ are distinguished from the larvæ by their somewhat larger size, by the presence of the fourth pair of legs, and of respiratory stigmata. They are distinguished from the females by the absence of the genital pore and of two depressions (areæ porosæ) excavated on the dorsal face of the base of the rostrum. They live like the females, having the rostrum implanted in the skin of their host, penetrating sometimes beneath it, and causing the formation of purulent swellings. Their size increases and their colour becomes darker. Finally, they leave their host for the ground, where they undergo the change which gives them sexual organs.

The males, always flat or little distended, find the females, either on the ground or on an animal—which they have joined before or

after the females—and they both prefer those parts of the body where the skin is fine and where they are not easily reached by the tongue, teeth, limbs, or tail of their host.

The **Ixodinæ** are found in every country, and especially in warm climates. They have been discovered on the most diverse species of vertebrata; but the specific determination of the different forms is rendered difficult by the great confusion that prevails. The male and female of the same species have often been mistaken for different species, and the same species has received distinct specific names because individuals belonging to it were observed on different hosts. We will mention only the more important species.

Ixodes ricinus (Linn.).—This Tick is very often seen on sporting Dogs. It is the best known species, and that of which Aristotle

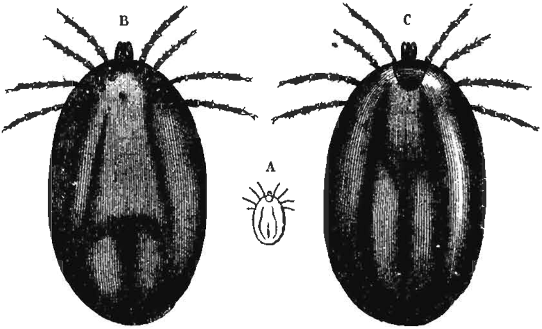


FIG. 55.—The Ixodes ricinus of the Dog, a fecundated female after feeding.—Railliet.

A, Natural size. B, Enlarged ventral surface. C, Enlarged dorsal surface.

speaks. It is named the *Common Tick* or *Dog Tick*, and is remarkable for the dissimilarity existing between the two sexes, with regard to the rostrum.

When fasting, the body of the female is oval, orange-coloured, not festooned on the posterior border, and measures 4 mm. long and 3 mm. broad. Replete and fecundated, it resembles a castor-oil bean, is of a leaden colour, and is 10 mm. to 11 mm. long, and 6 mm. to 7 mm. broad. The rostrum is long, with a hypostome furnished inferiorly with six longitudinal rows of teeth. The male, 2.5 mm. long and 1.5 mm. broad, has the body covered by a shield of a dull brown colour. The rostrum is shorter than that of the female. The legs, in both sexes, are terminated by long, slender tarsi, without a dorsal prominence.

Ixodes hexagonus (Leach).—This Tick may be distinguished, especially from the preceding species, by the tarsi, which are short and enlarged by a dorsal prominence near their extremity.

These two species appear to be spread all over Europe, whence they have passed into Africa, Asia, and America. They are encountered more particularly on the Dog, Sheep, Ox, and Horse: Man himself is sometimes attacked by them. In the larval, and even in the nymphal state, they often inhabit the skin of small wild Mammals—such as the Mole, Dormouse, Squirrel, Hare, Rabbit, etc. They are common all over France, and are found in the majority of European countries. The duration of their life extends, on the average, from the month of May to October. Towards the end of September, few are observed which have not attained adult age ; and from the commencement of October they are rarely found, males or females, even at that age.

Mégnin reports having often met with these Ticks on Cattle and Horses in Avergne, and on Sheep in the North of France ; but he has never seen them on cattle coming from Normandy, or from the West or East of France. It is, naturally, the females which live as parasites ; they prefer to attach themselves about the flanks, where the skin is thin and favourable for their implantation. When the parasites have filled themselves, they fall to the ground, and all traces of their having been on the skin soon disappear. The nymphæ, according to Mégnin, sometimes attack hunting Horses that pass over land covered with underwood and broom, and cause a more serious condition than do the punctures of the adults. These nymphæ, which are only 1 mm. to 2 mm. long, have singular habits ; not content with planting their beak in the skin : . . they lodge entirely beneath the integument, and by their presence there soon produce large pustules, which are really small boils, and are accompanied by intense itching. Mégnin gives an instance of a Horse which had the extremities of all its limbs studded with pustules, and beneath the crusts on these were found the bloated parasites in question. The Horse was cured by their successive extraction.

Mégnin has found similar pustules on the ears of Dogs and Hares, which were due, doubtless, to the same species of Ixodes that Trillibert obtained in a serous cyst of six months' duration, which was situated at the end of a Dog's ear.

Animals do not appear to notice the presence of these parasites ; the quantity of blood they extract is not sufficient to injure their health, and the wound they leave after they fall off heals quickly and spontaneously. Nevertheless, it is advisable to immediately remove all the Ticks from Dogs which have brought them in from hunting, as the fecundated female, falling on the floor of the kennel, there brings forth a population of parasites which may be very troublesome to get rid of. The Ticks may be removed by gentle, gradually-increasing traction, the pain caused to the Dog being insignificant. When the Tick has been too forcibly withdrawn,

it is often ruptured, and the rostrum remains in the wound, but is eliminated therefrom in a few days by a process of suppuration. It is therefore the best plan to compel the parasite to drop off, by touching it with a drop of benzine, petroleum, or oil of turpentine.

When the kennel is infested by Ticks, it may be freed from them by washing it with boiling water, which should be applied to every corner, and especially the ceiling, which these parasites prefer.

The *I. hexagonus* does not appear to cause any particular inconvenience to the Sheep. It fixes itself on parts destitute of wool—such as inside the arms and on the flanks. Nevertheless, serious losses have been reported among Lambs in Kent, by the debility resulting from Ticks, which had multiplied in an extraordinary manner. The species, however, was not well determined (*Veterinarian*, 1869).

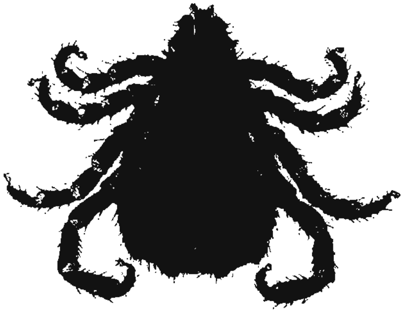


FIG. 56.—Ventral View of Male *Rhipicephalus* (*Boophilus*) *annulatus* of the United States, enlarged.—After Salmon and Stiles.

Rhipicephalus sanguineus (Latr.) may be recognised by the characters of the genus. The male, 3.5 mm. long, is covered by a dark-brown shield. The latter, of the same colour, is longer than broad in the female, which, according to her state of repletion, measures 3 to 11 mm. in length. In both sexes the coxæ of the first pair of legs are divided by two long and strong spines; the stigmata are comma-shaped. This species is common in the South of France, and it is also found in Italy, Algeria, and Morocco. It attacks cattle, Sheep, and Dogs. There is nothing particular in its action.

Rhipicephalus annulatus (Say) (*Boophilus bovis*, Riley—Figs. 56, 57) is distinguished by its shorter rostrum, with angular palps; the coxæ of the first pair of legs divided by two short spines; the

hypostome with eight rows of teeth ; and circular stigmata. Well known as the Texas fever Tick, this species (or varieties) is widely distributed in Africa, North and South America, Oceania, Asia, and Europe. Its life-habits may be gathered from the following observations by Mr. Lounsbury, Government entomologist, Cape Town, on the 'Blue Tick' (*Rh. annulatus var. decoloratus*) of South Africa :

'The eggs, to the number of several thousands, are laid on or near the surface in grass stubble or similar shelter, and the larvæ on hatching ascend the grass or bush, as in other species. Two thousand two hundred and fifty larvæ have been counted at the top of a single blade of grass. By day and by night, through wind, rain, and light frost they remain at their posts. Grass found infested and protected by a barrier of cut thorns was found to be still infested three months later, which shows that the young Ticks may live at least this length of time on the veldt. The female, after dropping from the

FIG. 57.—Dorsal View of Male *Rhipicephalus* (*Boophilus*) *annulatus* of the United States, enlarged.—After Salmon and Stiles.

host, starts laying in from five days to two weeks in summer, while in winter at Cape Town, at a temperature of 65° to 70°, she delays until the third or fourth week has passed. Similarly the incubation period of the egg varies from three weeks to three months. At a temperature of 85° to 90° in the incubator hatched eggs have been obtained in four weeks from the dropping of the mother Tick, which shows how heat hastens the development. Some moisture appears necessary during the incubation perod, as several batches of eggs kept in dry boxes have shrivelled and failed to hatch.

'The Blue Tick moults twice, but remains on its host through both changes thus differing materially in habit from the Bont, Red, and other South African species ; it, however, becomes motionless, and appears as if devoid of life before both moults. The larva begins to distend by the end of the second day of its attachment, and seems to cease enlarging in from three to three and a half days. Two days later, under a magnifying glass, the body contents may be seen to have shrunk away from the skin back to the mouth organs. Finally this larval skin ruptures across the top in front, and the Tick, now in the second, or nymph stage, crawls out. This change has been observed

to take place as early as six days from the attachment of the larva, and as late as the tenth. The nymph settles down near by, and after a few days distends, just as did the larva. In appearance it resembles the adult female, but its sides, in place of being parallel, converge slightly towards the rear. After the fifth day from the moult no further enlargement is perceptible, and doubtless feeding has ceased. In another day or two the outlines of the adult are dimly distinguishable through the translucent skin, particularly across the front, and shortly thereafter there is a rupture as before, and the Tick makes its appearance as the adult. The nymphic stage has about the same duration as the larval; in instances observed it has varied from seven to ten days. The two stages together in numerous cases occupied from fifteen to twenty days. The male is very similar to the female in size, colour, and general appearance just after the moult, and, being small, one might be easily mistaken for the other when viewed by the unaided eyes. The female settles down almost at once, and so, apparently, does the male; but the latter wanders much farther, and is therefore not easily traced. After a day or two males are seen crawling about in the hair evidently searching for mates. I am not certain how soon mating takes place after moulting, but my observations lead me to conjecture that both sexes feed for a short time, and that the male then lets go his hold, and looks for a companion. However that may be, the females nearly all have mates by the fourth day. Distention has begun by that time, and seems to proceed whether or not a male has come up; this is another point that needs confirmative observation. A few females observed have fallen in seven days, but the great majority have not fallen until after the ninth day, and some have remained until the eleventh. The male remains on the skin when his mate drops, but what becomes of him afterwards I have not observed.

'The life period on the host for the female is thus from three to four and a half weeks. No individual Ticks that I have observed have, however, dropped in less than twenty-three days, and most remained for twenty-six. The entire life cycle may be passed in two summer months, but, in fact, probably seldom takes less than two and a half or three. There is a possibility of three broods a year in our Cape climate, and a probability of at least two broods. The life period on the animal during the winter months is not likely to be more than a day or two longer than in summer, at least when dry weather is the rule in winter, as it is in our eastern sections. Being hidden in the hair when young, and pressed against the warm body of the animal, the Tick is kept warm throughout its stay. Numerous nymphs and some larvæ, which I scraped off after they had ceased to feed, moulted when kept in glass tubes; but the change in some cases took over a week in place of the two or three days as it would on the warm skin. Some of the adults obtained in this way were kept alive for twelve days in the tubes, and were then placed in spirit, as they can thus do without food, it cannot be necessary for them to settle down at once after moulting on an animal.'

The *Rhipicephalus annulatus* attacks cattle and sometimes Deer, Goats, and Horses. The change from larva to nympha, and, according to Lounsbury, the further change from nymph to adult, may be effected on the host, and both adult and larval Ticks may carry the parasite of Texas fever, Red water, or bovine Piroplasmosis, which exists more or less extensively in the United States, Australia, South Africa, Argentine Republic, Mexico, Roumania, Italy, West Indies, Russia, Germany, Southern France, Finland, England, Ireland, etc.

It is probable that more than one species of Tick transmits the parasite of Piroplasmosis to cattle, as Red water occurs in places where no species of *Rhipicephalus* has been found. In some isolated outbreaks of Red water the part played by Ticks has not

been ascertained, and it has been suggested that other agents than Ticks may carry the parasite from diseased to healthy cattle.

The connection of infected Ticks with the production of Texas fever was firmly established (1889-1893) by Smith and Kilborne's investigations, which have been summarized by Dr. G. H. F. Nuttall, F.R.S., Cambridge University, as follows:

'To find out if the disease could be communicated from Southern to Northern cattle in the same enclosure without the intervention of Ticks, Smith and Kilborne carefully removed Ticks from the Southern infected cattle. In this way no ticks could mature and infect the ground. The Northern cattle all remained healthy, proving that ticks were necessary to cause the disease. To determine if Texas fever could be produced without the presence of Southern cattle, and only by Ticks, fields were infected with mature Ticks, and susceptible cattle placed there acquired Texas fever. This proved that the Ticks alone could produce infection. Finally Smith and Kilborne demonstrated that young Ticks hatched artificially and kept in glass dishes in the laboratory (they were the young of infected Ticks dropped from Southern cattle), were capable of communicating the disease at any time of the year when placed on susceptible animals.

'At first it was thought that the gorged Ticks falling off, laying their eggs, dying and disintegrating, infected the fields, so that cattle feeding on the latter contracted the disease. This, however, was disproved by the negative result of feeding experiments with adult Ticks, Tick eggs, and grass from infected fields. That the excreta of infected cattle do not communicate the disease was proved in the experiments where infected cattle free from Ticks were allowed to pasture in the same field with susceptible animals. A field in which blood and crushed organs of infected cattle had been spread also did not cause infection.'

The destruction of Ticks in cattle can be effected by the application of Acaricides in the form of a smear or a dip. Hand-picking may be tried when only a few animals are infested, the Ticks being touched with benzine, petroleum, turpentine, or tobacco juice, then removed by forceps or by hand, and destroyed by burning. But hand-picking is both tedious and uncertain, as the larvæ and nymphæ are small enough to be overlooked. To be effective this method should be followed by smearing with a mixture like that recommended by Cooper Curtice: kerosene, 1 gallon; lard, 10 pounds; sulphur, 1 pound; pine-tar, 2 pounds. This smear is applied with a brush.

When large numbers of cattle are infested dipping must be resorted to, the animals being made to swim through a tank containing from 400 gallons to 2,500 gallons of a reliable parasiticide. Norgaard was successful with chloronaphthol, 50 pounds, dissolved in 2,500 gallons of water containing 40 pounds of soap. Gray and Robertson (Rhodesia), employ a dip composed of arsenic, 6 pounds; soap, 24 pounds; washing soda, 24 pounds; wood-tar, 5 gallons; and water, 400 gallons.

With the object of bringing about the destruction of Ticks on pastures various measures have been advocated. Morgan, after experience of Texas fever, advises keeping cattle off infested pastures for eighteen months, or until the Ticks, in the absence of their hosts, have perished. Others, including Lignieres, suggest

sowing the land with lucerne, better drainage, ploughing up, top dressing with gas lime, burning off the grass, fencing off infested parts, etc.

The **Egyptian Tick** (*Hyalomma Ægyptium* L.) is a very widespread species which infests cattle in Northern Africa, and which is found on those brought into European markets from that country, and particularly to the French markets. It has a brown dorsal shield, without spots, brilliant hemispherical eyes, lodged in a fossette. The coxæ of the first pair of legs have two long and strong spines; the other articles, except the tarsi, are brown at their base, and yellowish at the other extremity. The male measures 6 to 7 mm. in length. The replete female may attain enormous dimensions—20 mm. in length, 18 mm. in breadth, and nearly as much in thickness.

This Tick—the largest known species—is very common in Egypt, in Algeria, and in most parts of Africa. We believe it to be related to a species we received from Guadeloupe, through Couzin, where it is known as the *Tique sénégalaise*. It has been considered, in fact, as derived from Senegal, whence it must have been imported with Cattle into the countries in which it is now seen. It is stated to be a stranger in Martinique, which, notwithstanding its proximity to Gaudeloupe, will doubtless remain exempt from it, as that island does not receive African Cattle.

We have the opportunity of meeting with this Tick in the abattoirs of France, on Algerian Oxen; and Mégnin even affirms that it will eventually become acclimatized in the South of France, in the neighbourhood of Marseilles, by the temporary sojourn of African Cattle in that town and its environs, before their departure for the different markets. He bases this assertion on what he has observed with regard to the Green Lizard of Provence, on which he found a male Tick that he believes is the Egyptian one. It has been known for a long time that the male of this species often fixes itself upon reptiles—such as the Greek and Mauritanian Tortoise—and on Lizards.

The Cattle that Mégnin has seen carrying swarms of these Ixodinæ about their flanks, and the other parts of the abdomen, did not appear to suffer, nor did they try to remove them; they arrived at Paris in good condition. Nevertheless, in Africa the Algerian Ixodinæ are not always inoffensive, for Lucas relates having seen, in 1845, in the district of Calle, Algeria, Oxen die from exhaustion through the attacks of the parasites, which were incessantly renewed on the surface of their bodies. Each female, in fact, attaining in its full plenitude the size of a hazel nut, it can easily be understood how this great subtraction of blood, repeated so very many times, should operate prejudicially on nutrition, to say nothing of the irritation set up on the skin. And the same effects have been witnessed by Couzin on the Horses, Cattle, and Mules in Guadeloupe. In addition, the wounds resulting from the punctures of these parasites become ulcers under the influence of the torrid

climate. According to the opinion of Mégnin, it is possible that this ulceration is primarily due to the custom of removing the Ticks by means of hot knives; the rostrum remaining in the skin causes eliminating suppuration, which leads to obstinate sores.

In Guadeloupe, the Ixodinæ of Senegal are supposed to play an important part in the development of a serious affection known there as *farcy*, which is witnessed in Horses, Cattle, and Mules; the ulcerous wounds just referred to are the starting-point of the disease. Nocard has demonstrated that this 'farcy of the Ox' is a malady of microbic origin; but it can be conceived that the Ixodinæ may be the agents of inoculation of the micro-organism that determines the disease. It may be mentioned that this 'farcy' is not known at Martinique, where there are no Senegal Ticks. *Rhipicephalus annulatus*, which is also frequent in Guadeloupe, where it is named the 'creole Tick,' is not implicated in this etiology of farcy, as its puncture does not leave any trace because of the rostrum being so slender.

Dermacentor reticulatus.—This Tick has the dorsal shield marbled with milky spots on a brown ground. Length 5 mm.; the replete female may attain a length of 16 mm. by 10 mm. in breadth.

This species is widely distributed in Europe, where it is found on the Sheep and Ox, sometimes on the Goat and Horse.

Hæmaphysalis punctata (Can. and Fanz.).—Has a light brown shield, longer than broad in the female. Length 4 mm.; the replete female may be 12 mm. long.

Hæmaphysalis concinna (Koch).—Is distinguished from the preceding species by the discoid shield in the female, by the palps which are curved in front in the form of pincers in the male. Both live on the Sheep, sometimes on the Ox, Goat, Horse, and Dog. The first is more extensively distributed than the second.

Hæmaphysalis Leachi (Adouin).—Is characterized by the palps, of which the second article is very acute at its posterior border, and carries two retrograde spines—one dorsal, the other ventral.

Various regions of Central and South America are much infested by numerous species of Ixodidæ, which rapidly increase there, and attack nearly indifferently all the domesticated animals, sometimes even Man. They are known locally as *Ticks, Prickers, Garapattes*, and *Carapatos*—names which are applied indifferently to species of Ixodinæ and Argasinæ. The Ixodinæ belong chiefly to the *Amblyomma*. The species that appears to be most prevalent is *A. cajennense* (Fab), which is common on the Horse, Ox, and Dog. In this tick the dorsal shield is marked by yellowish-white spots; it is triangular in the female, and in the male it is relieved by smooth radiant prominences. The coxæ of the first pair of legs have two widely-separated conical spines, the external longer than the internal.

The Horse, owing to his mode of living on the prairie, is often covered with these Ticks. They may be seen on all parts of the body, but they seem to prefer those regions which the Horse cannot easily reach—as the sides of the neck and inner surface of the thighs. Animals do not appear to suffer from the presence of these parasites; though Kalm, cited by de Geer, relates having seen horses 'which had the under part of the belly and other regions of the body so covered with these Ticks that it was hardly possible to

introduce between them the point of a knife. They were so deeply buried in the flesh of one animal that it finally succumbed.'

Two other species, also well known, are *Amblyomma Americanum* (L.) or *Acarus nigua* (de Geer) (which may be recognised by the long spine carried by the coxæ of the fourth pair of legs in the male), and *Amblyomma maculatum* (Koch), which is furnished with a single and very long spine on the coxæ of the first pair of legs. In the United States, where it is widely distributed, *A. Americanum* is known as the 'Lone Star Tick.' It is quite common on Cattle, and sometimes is found on Man.

Africa, and particularly South Africa, is also richly provided with the Ixodidæ. It appears to be the native country of the genus *Rhipicephalus*, which is represented there by most of its species, all very closely related to one another and very similar to the type *Rh. sanguineus*, which also abounds there. The principal species are *Rh. appendiculatus* (Neumann), (Cape Colony, Transvaal, Rhodesia, etc.), which transmits the parasite of Rhodesian fever; *Rh. simus* (Koch) in nearly all Africa; *Rh. bursa* (Can. and Fanz.), of the North and South; and also of Southern Europe, where it transmits the parasite of, '*Carceag*,' or Ovine piroplasmosis; *Rh. capensis* (Koch), of the South and East; and *Rh. Evertsi* (Neumann) of the South. All these may attack the different domestic animals. The African species of *Amblyomma* are also very numerous. The principal one is *A. variegatum* (Fabr.), which may be recognised by its prominent hemispherical eyes, and by the yellowish-red spots of its shield. It is common on the Ox, Sheep, and Horse, and it does not spare Man.

Argasinæ.—The *argasinæ* are distinguished from the *Ixodinæ* by the following characters: The rostrum, instead of being terminal, occupies the inferior face of the cephalothorax. The maxillary palps are antenniform—that is, formed of cylindrical, subequal articles, very movable on each other. There is no scutellum.

We recognise two genera: *Argas* and *Ornithodoros*.

Argas (Latr.).—Body, usually flat, has thin borders, without deep ventral grooves. There are no eyes.

Ornithodoros (Koch).—Body has thick borders, more or less distended; deep ventral grooves always present, and sometimes eyes.

In Europe only one species is at all common. It is *Argas reflexus*, which lives on birds. In hot countries, such as Asia, Africa, and America, there are several species that attack man and the domestic animals.

1. **The Persian Argas** (*A. persicus*—Fischer).—Known under the name of the *Miana Bug*, by reason of the locality which it more particularly infests; is common in Persia. It constitutes a scourge for travellers and for the poultry-yards in that country.

2. **The Ornithodoros of Tholozan** (*O. Tholozani*—Lab. and Még.) has the body relatively narrow, with parallel lateral borders, the anterior extremity terminating in a blunt point, the posterior rounded, and the integument very finely gauffered. The adult females are 8 to 10 mm. long, and 4 to 5 mm. broad. In a state of repletion their colour is a deep violet.

In Persia this species is reputed very dangerous to Man. It is known as the *Kéné*, or *Sheep Bug*; it lives, in reality, on the Sheep, on the Camel, and on the Fowl.

3. **The Ornithodoros of Savigny** (*O. Savignyi*—Adouin) may be recognised by its legs, which have the articles notched on their dorsal border, and by its

thick body. The length varies between 5 and 12 mm. It lives in various parts of South Africa, where it attacks the Horse, Ox, Goat, and even Man—sometimes with very serious results.

4. **Turicata** (*O. turicata*—Dugès).—The 'turicata,' as it is called in Mexico, has a subrectangular body, nearly square, the anterior border angular and, obtuse; it measures 5 to 6 mm. long. The *Turicatas* infest the Pigs of Ganajuato, Mexico, fixing themselves on the inside of the forearm, and running somewhat rapidly. Their punctures sometimes cause very serious accidents to Man, and the Pig cannot always sustain them with impunity. 'It often happens,' says Dugès, quoted by Mégnin, 'that newly-purchased Pigs are put into pigsties where, owing to the carelessness of the owners, the Turicatas abound; some of the Pigs die during the night, and others are found incapable of getting up; if compelled to rise, they stagger and tumble about, and cannot maintain themselves. In the dead Pigs, the connective tissue is distended around each puncture with an ecchymotic effusion to an extent of 5 centimètres in diameter. I have never examined further to ascertain if there were any other disorders. Fowls which feed on the parasites, if only for a day, die in about three days, after becoming dull and ceasing to eat.' The Ox, Horse, Llama, and Man are often attacked by the Turicatas.

5. **Ornithodoros talaje** (Guér.).—Is distinguished from the preceding by its rostrum, which can be concealed under two lateral wings. It is found in Central America, where it attacks Man, the Llama, and probably the domestic animals.

6. **Ornithodoros Megnini** (Dugès).—This species has a lyriform body—the wide end being anterior—slightly angular in front and rounded behind. The female measures 5 to 6 mm. in length, and 3 to 3·5 mm. in breadth. The nymphæ, which are relatively large, have the body covered with spines. According to Dugès this species is very abundant in the State of Guanajuato. It is met with on the Horse, Ass, Ox, Sheep, and Dog, and principally in the ears; it often fixes itself on other animals, and sometimes on Man. Mégnin supposes that the numerous Ixodidæ, which attack animals in Mexico, and with which the horses of the French Military Expedition to that country were so much afflicted, ought to be included with this species. In the Western United States, where it is known as the Spinose Ear Tick, *O. Mégnini* is very troublesome. To dislodge the parasites Salmon and Stiles advise pouring a little olive or other bland oil into the ear. This causes the ticks to move, when they can be picked off and crushed.

II. **Gamasidæ** (see p. 85).—Two of the genera of this family have species living as parasites on the domesticated animals. These are *Gamasus* and *Dermanyssus*.

Gamasus (Latr.).—The species have the integument partially or wholly coriaceous; the mandibles are cheliform, and are similar or but little different in the two sexes. The larvæ are hexapodal.

One species only merits mention here—the **Gamasus pteroptoides** (Mégnin), so named because of its resemblance to the Gamasidæ of the genus Pteroptus. It lives in complete and permanent colonies at the bottom of the fur of Field-mice, Moles, and Rabbits, as well as on some Bats.

The whole rostrum is salient and uncovered; the inferior plastron is very small in the two sexes, and united by a membraneous integument to the superior plastron, which covers all the dorsal surface. The legs are nearly altogether of the same size, and similar in the two sexes; the hooklets and caruncle which terminate them are very developed. The nymphæ have a short peritreme. The body is squat, oval, and brown-coloured. The length of the female is ·55 mm., and the male ·45 mm., the breadth of both being ·30 mm.

This parasite subsists on the natural exudations of the skin of its host, and perhaps, also, on that which it produces by the bites of its mandibles ; but up to the present time it has not been observed to do any particular harm. It has only been mentioned expressly as related to the Rabbit. Turnbull has found in the ear of an Ox an Acarus that Leidy considered belonged to the genus *Gasmasus*. It will be referred to when treating of the 'Parasites of the Ear.'

The species of *Dermanyssus* (Dugès) may be found on the domesticated Mammals—such as the Horse, Ox, Dog, and Cat. But they are always accidental, and come from Fowls, which are their natural hosts. They will therefore be considered when dealing with the acariases of Birds.

III. **Trombidiidæ** (see p. 85).—This family is divided into numerous sub-families, only two of which interest us. These are *Trombidinæ* and *Cheyletinæ*. In the sub-family of *Tetranycidæ* is placed the *Bicho colorado*, of the Argentine Republic and Uruguay, which, according to G. Haller, is only a Tetranychus (*Tetranychus molestissimus*—Weyenbergh). This small Acarus, which is of a red colour, lives on the inferior surface of the leaves of *Xanthium macrocarpum*, in a web that it spins ; but from December to the end of February it throws itself on warm-blooded animals, Man himself not escaping its visitations. The *Bicho colorado* buries its rostrum in the skin, and causes insupportable itching (Railliet).

The Trombidinæ are Trombidiidæ with soft integuments, chelicerae terminating in booklets, palps composed of five articles, the fifth being club-shaped and articulated at the base of the fourth, which is prolonged beyond the fifth by a sharp hook. The legs have six articles, each leg ending in two hooks and a hairy cirrus. They have two eyes.

In this sub-family is found the genus **Trombidium** (Latr.), of which a species—the **Trombidium holosericeum** (Linn.)—lives as a parasite during its larval condition.

Like all the species of Trombidium, the latter has pedunculated eyes and a skin covered with bristly hairs. Specifically, it is recognised by its scarlet colour, its nearly square body—a little broader in front than behind, where the terminal border is notched on the middle line ; hairs and cylindrical papillæ cover the body : these are round or obtuse at the summit on the dorsal surface, bristly on the ventral surface and the legs. The length is 1·35 mm., and maximum breadth 1·8 mm.

This is a very widespread species—especially in the centre and West of France—abounding from the end of spring on grass-lands and sandy slopes, and in woods, but rarely in gardens. It is phytophagous, and is often designated—as well as the neighbouring species—the *Red Mite*.

According to Mégnin—whose opinion, however, has been disputed—the larval hexapod of the *Trombidium holosericeum* is the parasite long known as the *Rouget*, *Red Flea*, *Harvest Bug*, etc., which the older naturalists described as a species by the name of *Leptus autumnalis*.

The various designations given to it recall the period when it is most abundant. The female lays her eggs in July. The larvæ are orbicular in shape and orange-red in colour, the body being sprinkled with short, sparse hairs; they have the eyes and stigmata of the adult, and *six* long cylindrical legs, each with six articles. It attaches itself to any animal that comes in its way, implanting its mandibles in the skin. Its abdomen gradually becomes distended, and assumes comparatively considerable dimensions; it is then that it attracts attention, and is recognised by the various names given to it. It measures ·40 mm. long and ·25 mm. broad.

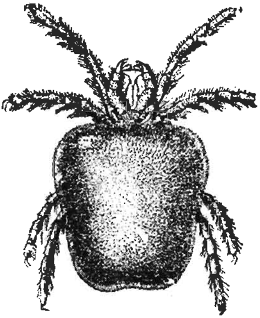


FIG. 58.—*Trombidium holosericeum*, female, seen on the dorsal surface; magnified twenty diameters.—Railliet.

The Harvest Bugs attack the small Mammalia by preference, such as Moles and Hares, which are sometimes literally covered with them; and Man is often invaded by them in the autumn, the Acari creeping rapidly along the limbs and fixing themselves on any part of the body, especially those parts which are clothed. Their punctures are accompanied by insupportable itching.

Among the domesticated animals, sporting Dogs are most exposed to trombidian acariasis. The first mention of the existence of this parasite on the Dog is due to Defrance; it has since been confirmed by Delafond, Mathieu, Mégnin, Friedberger, and other authors.

On returning from the field, Dogs often exhibit symptoms of great itching around the eyes and nose, and on the paws and belly. A close examination will discover the cause to be the Harvest Bugs, wandering or fixed by their rostrum either in the sudoriparous gland-ducts, or, according to Gruby, at the root of the hair. They are sometimes in groups of ten or a dozen around one hair.

Cats which frequent gardens may be affected in the same way, Delafond states.

According to an observation of Moreau, and confirmed by Railliet, what is known in France as the *rafle* or *feu d'herbe* of bovines, and described by Chabert, Fromage de Feugré, Lafore, Cruzel, etc., is nothing more than a case of trombidian acariasis. This affection, which appears towards the end of summer, has been ascribed by the older writers to feeding the cows on the grape-

stalks or newly-gathered forage. It occupies the inner surface of the limbs, and extends beneath the belly and on the shoulders, neck, and head, and consists of an eruption of pustules or hard pimples, from which exudes a serous or purulent matter that dries into crusts, and finally disappears as dust. In this way the malady disappears of itself. On cows so affected, Moreau has found colonies of this parasite, forming small disseminated patches of one or two square centimètres in extent.

On cavalry Horses returning from manœuvres after harvest, Blaise has observed an erythematous affection which did not extend above the knees or hocks, and which had been mistaken for chorioptic scabies, but was due simply to the Harvest Bug.

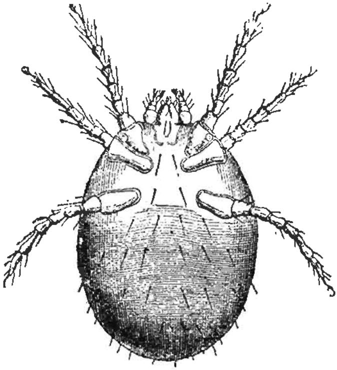


FIG. 59.—Harvest Bug, or larva of the Trombidium holosericeum, seen from the ventral surface; magnified one hundred diameters.—Railliet.

Csokor and Eloire have made a similar observation with regard to Poultry.

Otherwise, this affection is not serious. To free animals from the parasites, some frictions with a cloth sprinkled with benzine, with benzinated glycerine, or with sulphur ointment, are sufficient. A very dilute solution of carbolic acid (1 or 2 per cent.) is a good preventive, and also a curative agent.

Certain warm countries of America are infested by a Leptus of undetermined species, which torments Man or animals, and is named *Tlalsahuate* in Mexico, *Bete rouge* in Guiana, the Antilles, and Honduras, *Colorado* in Cuba, *Niaibi* in New Granada, *Mouqui* at Para, etc.

The sub-family of **Cheyletinæ** contains the soft-skinned Trombidiidæ, with styliform chelceræ, and palps composed of three articles, the second carrying one or three hooklets that extend beyond the last article. The legs have five articles, usually terminating in two hooklets and a cirrus. They have no eyes.

The species of Cheyletinæ are recognised by their enormous maxillary palps, the second article of which has a single, large, falciform hooklet extending beyond the last article.

There is a vagabond species that may be accidentally met with on the bodies of animals; this is the **Cheyletiella eruditus** (Schrank), so named because it is sometimes found in old books, as well as among rags, mouldy forage, etc. Picaglia has attributed to it a dermatosis observed on a Horse, resembling that produced by *Dermanyssus gallinæ*; but this opinion rests only on the fact that hay with which the Horse was fed contained numerous *Cheyletinæ*.

The **Cheyletiella parasitivorax** (Mégn.) lives normally on the Rabbit. It is commensal, or, rather, a useful mutualist, if it is true, as Mégnin affirms, that it pursues the soft parasites on its host, principally the Listrophorinæ. The body is an elongated hexagon in shape, and of a pale-yellow colour. The rostrum is large and pentagonal, and equal to a fourth or third of the size of the body, while the palps are about one-third the volume of the rostrum. The anterior legs are shorter than the posterior. The female is ·45 mm., and the male ·32 mm. long.

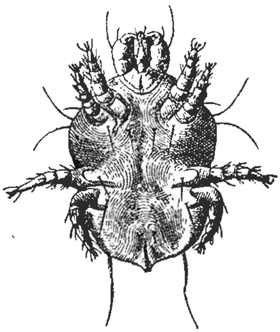


FIG. 60.—*Cheyletiella parasitivorax*, ovigerous female, ventral surface; magnified one hundred diameters.

IV. **Sarcoptidæ** (see p. 85).—The Acarina comprised in this vast family live in very diverse conditions, which are nearly fixed for each type, and to which their conformation is subordinate. Their division into five tribes or sub-families, as proposed by Mégnin, is generally adopted; these are: 1. *Sarcoptidæ detriticoles* or *Tyroglyphinæ*; 2. *S. gliricoles* or *Listrophorinæ*; 3. *S. cysticoles* or *Cytoditinæ*; 4. *S. plumicoles* or *Analgesinæ*; 5. *S. psorica* or *Sarcoptinæ*. To these may be added a somewhat, as yet, limited tribe, the *Sarcoptidæ epidermicoles*.

The last four of these tribes will not be alluded to here. The *Sarcoptidæ cysticoles*, or *Cytoditinæ*, the *Sarcoptidæ plumicoles*, or *Analgesinæ*, and the *Sarcoptidæ epidermicoles*, are exclusively peculiar to Birds, the first living in the connective tissue and air-sacs; the second among the feathers, being nourished by the greasy matters excreted by the skin; the Sarcoptidæ epidermicoles conceal themselves among the epidermic cells, the formation of which they expedite, and in this way constitute a transition to

the psoric Sarcoptidæ or Sarcoptinæ. The latter are the agents causing mange, or scabies, which will be dealt with in the following article, when treating of the psoric acariases of Birds.

The **Sarcoptidæ detriticoles,** or **Tyroglyphinæ**, are Acarina which subsist on decomposing animal or vegetable matters. Troussart and Mégnin have provisionally attached them to the *Sarcoptidæ insecticoles*, which have been studied by Berlese, and which resemble that tribe more than any other. The Tyroglyphinæ are only exceptionally met with on the domesticated animals, and then as foreign bodies. They correspond to the following description :

Body covered with a smooth, even, sometimes nodular integument, having silky, plumose, or palmate hairs. Legs alike, similar in each anterior and posterior group, and in the two sexes. The abdominal extremity also rounded in the two sexes (Mégnin).

These characters, compared with those of the other Sarcoptidæ, always permit the Tyroglyphinæ to be eliminated as simply accidental errant parasites when they are found on a domesticated animal. We shall, therefore, limit ourselves to an enumeration of the five genera in this tribe : *Tyroglyphus, Carpoglyphus, Glyciphagus, Cæpophagus*, and *Serrator.*

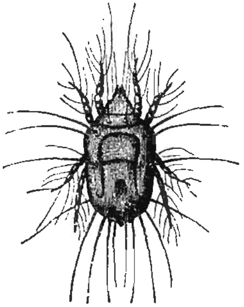


FIG. 61.—*Tyroglyphus longior.*

It is probably the *Glyciphagus domesticus* (Geer) that Hering discovered on a Horse's foot affected with 'canker'; the horse had recently died. He regarded it as special to the disease, and consequently designated it *Sarcoptes hippopodos.*

The **Listrophorinæ** have been designated *Sarcoptidæ gliricoles*, for the reason that they have been considered as peculiar to Rodents (Glires); they are also found, however, on other Mammals. They live at the bottom of the fur, and cause not the slightest irritation, the greasy matter of the skin sufficing for their nourishment. They are divided into two genera—*Listrophorus* and *Myocoptes*—only the first of which will be noticed.

The **Listrophorus** species (Pagenst.) have the body ovoid, compressed laterally, a large cephalo-thoracic plastron, the lip transformed into a kind of elongated pincers adapted to seize the hair. The *male* is provided with two copulatory suckers, and its posterior extremity is more or less notched. The *female* has the vulva between two groups of legs, and the posterior extremity is not notched.

Listrophorus gibbus (Pagenst.).—The cephalo-thoracic plastron is simply notched above. The posterior extremity of the male has a flat, bifid prolongation. The length of both sexes is about ·50 mm. It abounds in the fur of wild and domesticated Rabbits and Hares, on which it is seen twenty-four to forty-eight hours after the death of its host.

Listrophorus mustelæ (Mégnin).—The cephalo-thoracic plastron is divided into two pieces, which are movable on each other. The posterior extremity of the body of the male is simply notched. The length of the male is ·40 mm. to ·44 mm.; of the female, ·45 mm. to ·54 mm. It lives among the hair of the muzzle and anterior part of the body of the Ferret and Pole-cat.

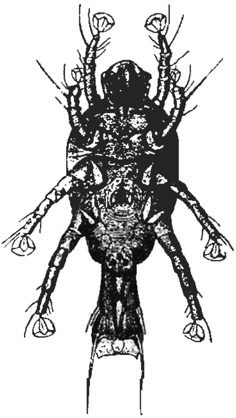


FIG. 62.—*Listrophorus gibbus*, male of the Rabbit, ventral surface; magnified one hundred diameters.

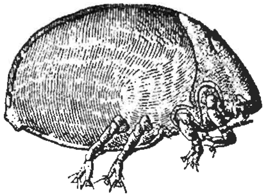


FIG. 63.—*Listrophorus gibbus*, female, of the Rabbit, seen in profile; magnified one hundred diameters.

ARTICLE II.—Psoric Acariases.

Psoric Acariases are caused by Acarina of the tribe of sarcoptinæ or by those of the family of Demodecidæ. Their common features are their gravity, their greater or less difficulty to cure, the rapid increase of the parasites, and the more or less serious alterations in the skin. They differ by the zoological nature of the acarina producing them, and by the location of these: the psoric sarcoptidæ living at various depths in the epidermis, the Demodecidæ locating themselves nearly exclusively in the sebaceous glands. It is advantageous to study separately the scabies due to the sarcoptinæ (*sarcoptinic scabies*) and that caused by the Demodex (*Demodecic scabies*).

1. *Sarcoptinic Scabies.*

Sarcoptinic scabies possess a high degree of interest, as they comprise nearly all the itches of Man and animals.

The *scabies* or *psora* was designated by the Greeks *ψώρα* (from *ψῶ*, I rub), and by the Romans as *scabies* (from *scabere*, to scratch).

It is known as *scabbia*, *rogna*, *raspa*, in Italy; *sarna*, *roña*, in Spain; *itch*, *scald*, *yuck*, *mange*, in England; *gale* in France; and *Krätze*, *Krätzausschlag*, in Germany.

History.—The history of scabies in animals is closely allied to that of the same disease in Man. It was nevertheless in the former that it was first mentioned in the Bible (Lev. xxii. 22). Moses excluded mangy animals from being offered at sacrifices.

Polybius speaks of an epidemic itch (*limopsoron*) which affected the whole of the people and horses of Cisalpine Gaul, and which Hannibal attributed to privations ('History,' Book III., 87).

The Greeks, and particularly the Roman agriculturists, were aware of the contagiousness of scabies, and the disasters that *turpis scabies* produced in the flocks. The Romans applied the word *scabies* to various affections of the skin, so that we cannot conclude from what they have written that they were really acquainted with the parasitic disease; but what proves that there was no confusion in the mind of Celsus, at least, with regard to it, is that he extends to Sheep-scabies several of his remarks on contagion, and indicates the course and treatment of the malady.

It is not until we arrive at the time of the Arab physicians that we find the first precise notions on itch, and learn that there was then an idea of its parasitic nature. Avenzoar (Ibn-Zohr), who lived in the twelfth century (1072—1161), makes the first mention of it, and indicates the existence of a disease caused by the presence of a little creature, popularly known as *soab*. He says: '*Oriuntur aliqui in corpore sub cuti exterius pediculi parvunculi qui, cum excoriatur cutis, exeunt animalia viva tam parvuncula quod vix possunt videri.*' Although the term *pediculi* is employed, there can be no doubt, from the mention of the seat of disease and the minuteness of the animalcules, that he had seen the Sarcoptes. But he was content with alluding to the fact, and did not seek to realize its great importance; for, like his contemporaries, he only saw in scabies the result of an alteration in the humours.

According to Fürstenberg, we find in the *Physica Sancti Hildigardis* (A.D. 1150)—the writer of which was the abbess of a convent on the Rupperts-berg, near Bingen—an indication of the remedies against the animalcule of the itch. This is named *suren*—a term popularly in use, which shows that a knowledge of the parasite of psora had become vulgarized in the North as well as in the South; the denomination was retained until the end of the seventeenth century.

After the time of Abenzoar, the notion as to the animalcule of itch was perpetuated in traditions, in teachings, and in publications, but with alternations of *éclat* and obscurity which allowed it to remain somewhat of a doubtful matter. A number of authorities of the thirteenth and following centuries speak of it. In Ambrose Paré (1664) is to be found this passage: 'The flesh-worms (*cirons*) are little animals concealed in the skin, in which they burrow, crawl, and gnaw bit by bit, causing a troublesome and scratching itchiness. . . . These flesh-worms should be extracted by means of pins and needles.'

The year 1634 is an important date in this history, because of the appearance of the book of Thomas Moufet (*Insectorum seu minimorum animalium theatrum*, London). For the first time, it clearly indicates the precise point where the sarcopt of human itch was to be found; for he expressly mentions that it was not to be sought for in the vesicles, but at the side of them: '*Hoc hobiter observandum, syrones istos non in ipsis pustulis, sed prope habitare.*'

About the same period, Hauptmann consecrated one of the first applications which had been made of the microscope—discovered in 1619—to an examination of the acarus, though he only gave a very imperfect drawing of it (1657). A book on Horses (Pferdeschatz) appeared at Frankfort nearly at this time, and in it mention is made of the Acari as *Moiben*, which live among the hairs of the tail, mane, and forelock of the Horse; but according to Gerlach, the writer mistook epidermic scales for animalcules. Wedel, in 1672, pointed out that acari were the cause of itch in the Cat. The attempts of Hauptmann were subsequently repeated by other observers, and notably by Michael Ettmüller, who published a more exact representation of the Insect.

In 1687, Cosimo Bonomo, in a letter addressed to Redi, gives a remarkably exact description of itch and the acari, after the investigations he had personally made, in common with the pharmacist, Diacinto Cestoni, of Livorna. He speaks of the form of the acari and even mentions that he saw one of these animalcules lay an egg at the moment when he placed it under the magnifying glass, so that he was able to make a drawing of it. Along with Cestoni, he arrived at the conclusion that the acarus is alone the cause of itch; that the disease is not engendered by perverted humours; that the contagiousness of the malady is perfectly explained by the passage of the creature from one person to another; and that internal remedies are useless in the cure of the disease, treatment being limited to external applications that would kill the parasite.

These exact notions, however, did not penetrate the mass of medical men. But in 1734, Linnæus recognised the parasite of itch (*Acarus humanus subcutaneus*), though he committed the grave error of considering it as belonging to the same species as the cheese-mite, of which he thought it was only a variety. The dissertation of Nyander, a pupil of Linnæus (*Exanthemata viva*), which appeared in 1757, raised a hot discussion; Nyander clearly proving that the acarus should be sought for in the furrows and not in the pustules; while Avelin—another pupil of Linnæus—attributed the itch of the Sheep, as well as that of Man, to the presence of an acarus, which he had perhaps not seen. So that the physicians remained divided between the humoral and the parasitic theories of psora.

In 1763, Sauvages wrote (*Nosologie*): 'The illustrious Linnæus has observed an itch on Cattle, which has much resemblance to leprosy in the thickness and hardness of its tubercles; it was caused and maintained by insects that were found located in these tubercles.'

In 1778, De Geer personally observed the Sarcopt, and gave the first exact figure of it, indicating, at the same time, the characters that serve to distinguish it from the cheese-mite. In 1786, a great observer—the Hanoverian physician, Wichmann—published an important memoir (*Ætiologie der Kratze*), in which, by new facts, he decisively established the parasitic doctrine of scabies almost as it is known to-day; and in a second edition of his work (1791), he successfully combated the objections raised against his views, with regard to metastases, repercussions, etc. He also published the hypothesis that the scabies of Sheep is likewise due to an acarus, and that the wool plays an important part in its propagation. Abilgaard, professor at the Copenhagen Veterinary School, wrote to him in 1787, to the effect that the treatment justified his theory, as by the exclusive employment of local applications he had cured a large number of mangy animals.

Unfortunately, Wichmann had left a loophole for the old prejudice in favour of psoric repercussions, as he admitted that these might be the possible consequence of the absorption of the excrementitial matters of the acarus; so that doubts and denials persisted. Kersting, the first director of the Hanover Veterinary School, had plainly seen the animalcules on mangy Horses; but he did not consider them the cause of the disease, as he could not succeed in producing it on a healthy Horse, by sprinkling the dust from the skin of an affected animal on it for fourteen consecutive days.

To Walz belongs the honour of the real discovery of the Sheep acarus in 1809. Soon after (1812), Gobier collected the parasites on mangy Horses,

and Saint-Didier gave an illustrated description of them. Gohier mentions Dorfeuille, sen., as the veterinary surgeon who, in 1813, discovered the acarus of the Ox; and he himself observed it during the following year on Hungarian cattle which had accompanied the Austrian army to Lyons. He adds that, by means of a magnifying-glass, he had seen the acarus of the Sheep, Dog, and Rabbit.

Notwithstanding the observations of Wichmann, Walz, Gohier, and numerous naturalists, the existence and action of the psoric acarus were generally unknown or disregarded in medicine; for, forgetful of the past recommendations, it was sought for in the vesicle, but could not be found, and therefore the conclusion was arrived at that it did not exist. Discussions on the opinions of the Ancients with regard to the animalcule continued until 1812, when Galès, pharmacist to the Saint-Louis Hospital at Paris, published a dissertation on the itch, and announced that he had constantly found in the *pustules* the creature so much sought after, and of which he gave a sketch. This work attracted considerable attention, and according to Alibert, Galès appeared to have established the reigu of the Sarcopt. But nobody else could discover the mysterious flesh-worm, and it was still sought for in the vesicles, on the indications of Pinel, who had assigned it that location. During more than fifteen years, the figure published by Galès was reproduced in every book on the subject, as an exact representation of the itch parasite. He had communicated the disease to himself by the transfer of an acarus, and he had experimentally transmitted it to children. Nevertheless, it was asserted that his pretended discovery was a gross error, if not an imposture. Raspail, who, like so many others, acting on the directions of Galès, had unsuccessfully attempted to find the parasite in the vesicles, in 1829 demonstrated that the animalcule represented by Galès was only the *cheese-mite*.

After these unfortunate attempts, incredulity resumed its sway, and was extended even to the writings of the older observers. The inscrutable animalcule was all but renounced when, in 1834, a Corsican—Francis Renucci, studying medicine at Paris—hearing the existence of the acarus denied at the Saint-Louis Hospital, proposed to show it forthwith; he imitated the procedure of the poor women in his country, in extirpating the Sarcopt at the point of a needle carried to the extremity of the irregular furrow leaving each vesicle. From that moment the nature of scabies was definitely recognised, and the correctness of the observations of Moufet, Nyander, Wichmann, and many other previous observers, was fully acknowledged.

The most recent investigations have had for their principal object the anatomy and physiology of the acarus, as well as the scientific treatment of scabies based on the teachings of natural history. The excellent thesis of Renucci (1835) is evidence of this; also the work of Albin Gras (1834), who, from a therapeutical point of view, studied the action of certain agents on the Sarcopt; that of Aube (1836), in which the parasite is represented as a noctambulist creature; and the memoirs of Raspail, Eichstedt, Lanquetin, Robin, etc.

With regard to scabies in animals, we have already mentioned the first allusion made to the acarus of the Cat by Wedel in 1672, then to its real discovery on the Sheep and Fox by Walz in 1809, and on the Horse, Ox, Dog, and Rabbit by Gohier in 1812 and 1814. It should also be mentioned that at the commencement of this century, Havemann, quoted by Zürn, already knew the mange acarus of the Horse, and gave a passable drawing of it. The itch parasite of the Pig and Wild Boar was found by Spinola in 1846. But our knowledge of the various species of Acarina of scabies has been more especially extended by the classical works of Gurlt and Hertwig (*Vergleichende Untersuchungen über die Haut des Menschen und über Krätz und Räudemilben*, Berlin, 1844), of Gerlach (*Krätze und Räude*, Berlin, 1857), of Fürstenberg (*Die Kratzmilben der Menschen und Thiere*, Leipzig, 1861), of Ch. Robin (*Mémoires sur diverses espèces d'Acariens de la famille des Sarcoptides*, Moscow, 1869), and of Delafond and Bourguignon (*Traité pratique d'entomologie et de pathologie comparées de la psore*, Paris, 1862). The name of Mégnin should also be honourably associated with these, because of the numerous memoirs

he has contributed on the various groups of Acarina, and especially those of psora.

General Characters of the Psoric Sarcoptidæ.—The body of these is oval or orbicular, obtuse at both ends, convex above, flat below, marked by fine, symmetrical, and sinuous streaks, except at those parts where there are thickenings named *plastrons*. It has, besides, at different points, pricking bristles or hairs.

There is a conical, mobile rostrum in front; the maxillo-labial spoon, situated at the inferior surface, comprises two lateral pieces or maxillæ joined to a posterior middle piece or chin, and is united, in the opening of the angle thus formed, by a thin membrane or lip. The floor of the mouth is constituted by the languette, a single lancet-shaped piece. The cheliceræ are placed longitudinally on the upper surface of the lip and languette, but do not adhere to them; they are flat on their inner surface, by which they come into contact, and so limit the supero-lateral walls of the mouth, which is a *prismatic cavity with three surfaces*. Each of them is formed of two articles, one of which, the shorter, is articulated on the other, which is the entire length of the organ; from this results a kind of pincer, with dentated branches. The maxillary palps are cylindrical or conical, and situated on nearly the same plane as the cheliceræ; they curve round these, their convexity being external; of their three articles, the basilar, which is very large, articulates with the corresponding maxilla, or with the latter and the chin. Finally, outside the palps there are sometimes transparent, cariniform, membranous expansions which Ch. Robin terms *cheeks*, and which, leaving the margin of the anterior part of the cephalothorax (*camerostoma*), are applied to the palps, the curvature of which they follow.

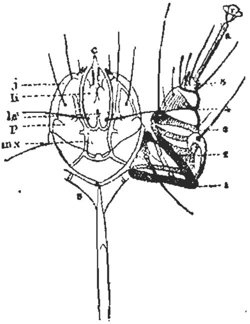


FIG. 64.—Rostrum and leg of the first pair of the *Sarcoptes scabiei*, var. *equi*; magnified 300 diameters.—Railliet.

c, chelicerae or mandibles; *mx*, maxillæ; *la*, languette; *li*, lower lip; *j*, cheeks; *p*, maxillary palps; s, sternum; 1, 2, 3, 4, 5, articles of the leg; *a*, sucker.

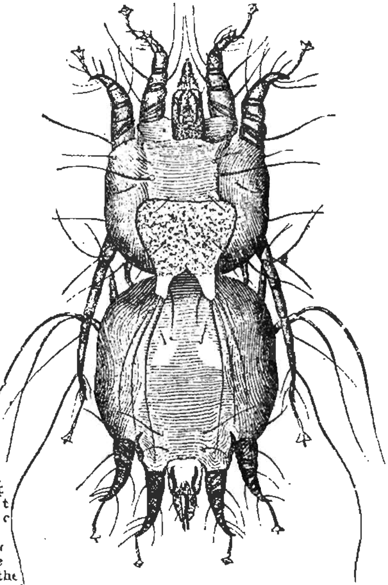
The legs have for base the *epimeres*, skeletal pieces that strengthen the integument. Each of the five articles (*or joints*) *composing them*—*which* are, passing from the base to the distal extremity, the ***haunch*** (*coxa*), ***trochanter***, ***thigh*** (or *femora*), ***shank*** (or *tibia*), and *tarsus*—comprises a solid piece and varied appendages, hairs, or bristles. The tarsus is terminated by a long bristle, or by an ambulacrum composed of a transparent pedicle of one or three pieces, and a campanulated expansion or sucker, which ensures adhesion to the smoothest surface.

The digestive apparatus, with rare exceptions, is only observable at its two orifices. The anus is a longitudinal, median slit, usually situated at the posterior border, but sometimes on the upper surface, and only at a tangent to the posterior border.

The sexes are distinguished by peculiarities in the legs and the general shape of the body, by details in the organization of the external parts of the genital apparatus, and by the size—the male being always smaller than the female.

The male organ is situated between the two last legs, on the middle line.

It comprises a small number of strong chitinous pieces that form a complex genital armour, which protects or directs the penis. Behind this arrangement there are often two circular suckers, placed symmetrically on each side of the middle line, which serve to fix the male to the female. The posterior border, in regard to these two copulatory suckers, has usually two prolongations or lobes furnished with several bristles, which may have a share in copulation.



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The psoric Sarcoptidæ attack the epidermis of the animals upon which they live, and their punctures are followed by the formation of more or less thick crusts, probably because they deposit a venomous saliva in the small wounds.

They are oviparous, sometimes ovoviviparous. The eggs are ovoid, their contents granular, and the shell transparent. When they are advanced in hatching, the embryo can be distinguished with its three pairs of well-developed legs bent beneath the body, and converging towards the centre, the hairs lying along them.

Incubation only lasts for a few days, as has been ascertained by Eichstedt, Bourguignon and Delafond, Gerlach and Burchart, Gudden and Fürstenberg. Bourguignon, like Eichstedt, fixes the period at ten days, he having seen the eggs of the *Sarcoptes scabiei* which had been kept in a small stove at the temperature of the body, hatched in about that time. Fürstenberg states that the period is from six to seven days. Gerlach has hatched them in about three days; after assuring himself of the limpidity of the contents of the eggs, he placed them between two glass plates which he carried upon himself day and night, from time to time allowing a drop of water or saliva to pass between the plates. Burchart, who experimented at the same time, placed the glass plates in a pocket in his underclothing, which he left off at night; the eggs were two days later in being hatched, or five days' incubation (S. Verheyen). These different results are conformable with the varied physiognomies the course of scabies may assume. The disease seems to sleep in winter, to waken up into activity on the return of warm weather. It is therefore established that the duration of incubation varies according to more or less favourable conditions, dependent upon the season, the activity of the local circulation of the mangy animal, the thickness of its coat, etc. Considering the rapidity with which the disease is developed in certain cases, Mégnin is inclined to diminish this duration; and he estimates that when all the conditions are favourable, from twenty-four to forty-eight hours may suffice for incubation.

The duration of the germinative faculty of the eggs—the maximum time about which, when removed from the body of the host, they can yet give origin to the embryos—has not been determined. Gerlach has, however, seen the eggs of the Sarcopt of the Horse hatch after four weeks. It is certainly an interesting question to solve, as it is the one upon which the duration of activity of the contagion of scabies depends.

When the larvæ issue from the eggs, they undergo those metamorphoses which have been more especially made known by the researches of Delafond and Bourguginon, and Fürstenberg and Mégnin.

1st Age. Larva.—The small acarus just hatched differs chiefly from the adult of the same species, by the absence of the fourth pair of legs and the genital organs, and by its smaller size. At the back part of the abdomen are two more or less long bristles. In this state it is named a *larva*

(De Geer), and before passing to the second age it has to submit to two or three moultings, in order to allow it to grow. At each of these crises it becomes inert, and all its parts are reduced to a cellular mass, at the expense of which the organs are formed anew—the change taking place within the integument, this playing the part of a shell; according to the expression of Claparède, the animal again becomes an ovum.

2nd Age. Nympha.—The last moulting of the larva brings it to the second age—that of *nympha* (Dugès). It is characterized by the presence of the fourth pair of legs, which are a little smaller and are less complete than those of the female, which the nympha most resembles. There are as yet no sexual organs. With the nymphæ there is not so much variation in size as is the case with the larvæ, proving that there is little or no moulting during this age, which is otherwise very brief. It may be remarked, however, that there are two different sizes among the nymphæ, but both in moulting arrive at puberty, the smaller being the males, the larger the females (Mégnin).

3rd Age. Male and Female at Puberty.—The metamorphosis of the nymphæ brings the Sarcoptidæ to the age of coupling; it is the last for the males, which are now recognised by their sexual characteristics, the females having only the vulvo-anal slit and are named *pubescent females.* The pubescent male and female have the various parts of the integument more accentuated and deeper coloured than in the preceding states. Copulation is accomplished in varied conditions. The termination of existence in the male is principally devoted to the accomplishment of that act; but the female undergoes another moulting and then arrives at the fourth age.

4th Age. Ovigerous Female.—This fourth age—the egg-laying age—is recognisable by the presence of the sub-thoracic vulva, and the *ovigerous female,* as she is now termed, also undergoes modifications in the third and fourth pair of legs, or in the latter only, varying according to the genus. In the abdomen—the walls of which are transparent—can often be perceived one or more eggs, which will be extruded according to circumstances connected with the habitat and genus of the creatures.

'Judging from the number of ova Gerlach found in a gallery of the Sarcopt, he certainly did not exaggerate in attributing to each female an average production of fifteen individuals—five males and ten females. The generative faculty being reached when fifteen days old, he fixed a progressive rate of increase which had no pretension to mathematical exactitude, but which gives an idea of the multiplication of these parasites, and the rapidity with which scabies is propagated among agglomerations of Men or animals.

1st generation after	15	days	10	females	5	males.
2nd ,,	30	,,	100	,,	50	,,
3rd ,,	45	,,	1,000	,,	500	,,
4th ,,	60	,,	10,000	,,	5,000	,,
5th ,,	75	,,	100,000	,,	50,000	,,
6th ,,	90	,,	1,000,000	,,	500,000	,,

So that from two individuals, male and female, there are one million five hundred thousand descendants in about three months. The reproduction of an animal species is on a par with its chances of destruction; when mangy animals are left to themselves, these chances are less than for a multitude of other invertebrates, and if we might judge from the extent of the crusts and the number of animalcules, necessary to cause the formation of these and to maintain them, the enormous multiplication established by this computation does not appear to be exaggerated' (S. Verheyen).

The habits of psoric Sarcoptidæ vary with the genera and species. All the Acarina are divided into three very distinct genera: *Sarcoptes*, *Psoroptes*, and *Chorioptes*.

The **Sarcoptes** (Latr.) (σάρξ, flesh; κόπτειν, to cut) are recognised by their rounded or slightly oval body; short rostrum, margined by two cheeks; short, thick, conical legs, the two posterior being quite or nearly concealed beneath the abdominal surface; the tarsus has often a sucker, with a simple and somewhat long pedicle; the male is usually destitute of copulatory suckers, and never has abdominal lobes.

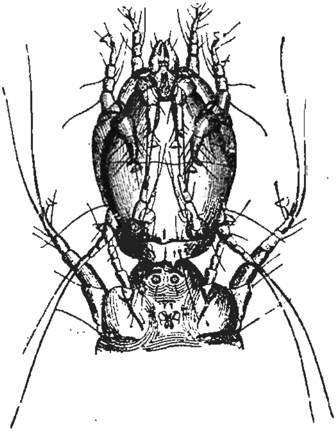

FIG. 66.—*Chorioptes auricularum*: a pubescent female being transformed into an ovigerous female during copulation; magnified one hundred diameters. The male has been slightly separated by compression of the preparation.—Railliet.

The **Psoroptes** (*Psoroptes* P. Gerv., *Dermatodectes* Gerlach, *Dermatokoptes* Fürst.) (ψώρα, psora; πτήσσειν, to conceal) have the body oval; rostrum conical, elongated, and destitute of cheeks; the legs are thick, especially the anterior ones, and are all visible outside the lateral margins of the body; the ambulatory suckers are carried on a long tri-articulated pedicle; the male has copulatory suckers and abdominal prolongations.

The **Chorioptes** (Gerv. and Bened., 1859) (Syn.: *Symbiotes* Gerlach, 1857; *Dermatophagus* Fürst., 1861) have an oval body; rostrum slightly conical, as broad as it is long, and destitute of cheeks; the legs long, thick, and visible beyond the sides of the body; the ambulatory suckers are very wide and carried at the end of a simple and short pedicle; the male has copulatory suckers, and more or less developed abdominal prolongations.

Sarcoptes.—This genus comprises a small number of species forming three sections or sub-genera—*Sarcoptes*, *Notœdres*, proper to the Mammalia, and *Knemidokoptes*, special to Birds.

The Sarcoptes properly so called have the body orbicular or ovoid, provided with squamiform prominences, and spinules on the notogastrum. The males have no ambulatory suckers on the third pair of legs, and never have any copulatory suckers. The pubescent and ovigerous females have on the first two pairs of legs ambulatory suckers, and on the other two pairs only hairs. They are oviparous.

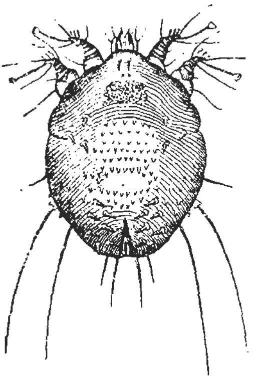

FIG. 67.—*Sarcoptes scabiei*, var. *equi* : ovigerous female, seen on the dorsal surface; magnified one hundred diameters.

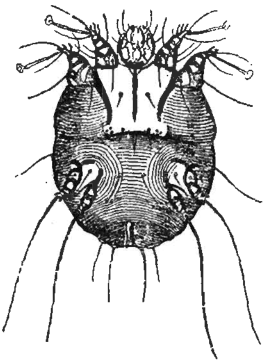

FIG. 68.—*Sarcoptes scabiei*, var. *equi* : ovigerous female, seen on the ventral surface; magnified one hundred diameters.

This section contains only one species—the Sarcopt of scabies.

The **Sarcopt of Scabies** (*S. scabiei* De Geer, *S. communis* Del. and Bourg.) has the body slightly oval, marked by parallel ridges, which are interrupted on the dorsal surface, as far as the sides, by acute conical projections. This surface has, besides, two long needles or spinules on the border of the epistome; three short and thick spinules, in triangle, on each side, behind the origin of the second pair of legs; seven spinules disposed in four rows—two on each side of the middle line—on the posterior quarter of the body; and a chitinous, granular plastron on the cephalothorax, in front of the groups of three spinules. There are two long bristles on each side of the anus, which is retrodorsal. The first two pairs of legs are provided with ambulatory suckers; the fourth pair have them in the male. In the latter the third pair, and in the female the third and fourth pairs of legs, carry a long bristle, instead of a sucker.

The *Sarcoptes* live on Man and a large number of Mammals and by their presence cause the development of ordinary itch or

mange. One peculiarity in their habits consists in the female depositing her eggs at the bottom of furrows or sub-epidermic galleries, a circumstance that renders the cure of scabies somewhat difficult.

The *Sarcoptes scabiei* varies in its dimensions and in secondary anatomical details, according to the species of Mammal it lives upon; hence it happens that there are somewhat numerous varieties, which many authorities have described as so many species. According to Mégnin, it is more particularly the dimensions that may serve to characterize varieties; and these dimensions 'are closely related to the thickness of the skin of the animal which affords them a habitat. So it is that the Pachydermata maintain the largest variety; then come the Carnivora, next the Ruminants, the Rodents, etc.' These varieties—which we distinguish after the name of their host—are nine in number, and may be classed in the

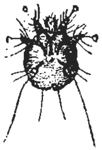

FIG. 69.—*Sarcoptes scabiei*, var. *equi*: hexapod larva, seen on the ventral surface; magnified one hundred diameters.

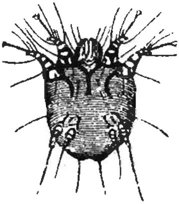

FIG. 70.—*Sarcoptes scabiei*, var. *equi*: octopod nympha, seen on the ventral surface; magnified one hundred diameters.

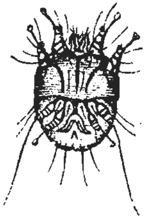

FIG. 71.—*Sarcoptes scabiei*, var. *equi*: male, seen on the ventral surface; magnified one hundred diameters.

order of their decreasing dimensions: *suis, equi, vulpis, lupi, capræ, cameli, ovis, hydrochœri, hominis*. We will only notice here those which live on the domesticated animals.

The SARCOPT OF THE HORSE (*S. scabiei*, var. *equi*; *S. equi* Gerlach) has the body of an elongated oval shape, measuring ·43 mm. to ·47 mm. in length in the ovigerous female, and ·25 mm. to ·28 mm. in the male; the breadth being in the former from ·32 mm. to ·35 mm., and in the latter ·18 mm. to ·20 mm. It lives on Solipeds.

The SARCOPT OF THE SHEEP (*S. scabiei*, var. *ovis*; *S. squamiferus ovis* Gerl.) has the six anterior spinules on the back short, in the form of an acorn; the fourteen posterior spinules are longer and fusiform. In the Sheep it causes scabies of the head. Mégnin has also found it on Mouflons and Gazelles. The length of the ovigerous female is ·35 mm. to ·49 mm., of the male ·22 mm. to ·25 mm.; the breadth of the former is ·20 mm. to ·36 mm., and of the latter ·16 mm. to ·19 mm.

The SARCOPT OF THE GOAT (*S. scabiei*, var. *capræ*; *S. capræ* Roloff) is identical with the preceding, and its dimensions are nearly the same. The

length of the ovigerous female is ·35 mm. to ·44 mm., of the male ·21 mm. to ·25 mm.; the breadth of the former being from ·27 mm. to ·34 mm., and of the latter ·17 mm. to ·22 mm.

The Sarcopt of the Pig (*S. scabiei*, var. *suis*; *S. squamiferus* Fürst.) resembles the preceding two. The ovigerous female measures ·40 mm. to ·50 mm. long, and the male ·25 mm. to ·35 mm., the former being ·32 mm. to ·39 mm. broad, and the latter ·19 mm. to ·30 mm. This variety has also been observed on the Dog.

Another variety found on the Pig by Guzzoni is much smaller in size, the female being ·29 mm. long, and ·21 mm. broad; the male ·17 mm. long, and ·13 mm. broad.

The Sarcopt of the Wolf (*S. scabiei*, var. *lupi*; *S. sc. crustosæ* Fürst.) has been found by Mégnin on Wolves affected with mange, and he has identified it with that which, according to Fürstenberg, causes in Man the crusty form of scabies known as the *Norwegian itch*—from the country in which it most frequently appears—and that form of mange which affects Deer kept in menageries. Railliet and Cadiot have also seen this parasite on a Dog affected with crusted mange.

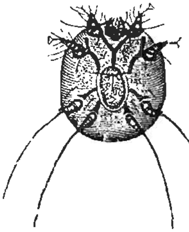

Fig. 72.—*Sarcoptes minor*, var. *cati*: an ovigerous female, seen from below; magnified one hundred diameters.

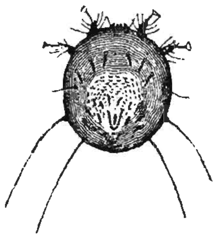

Fig. 73.—*Sarcoptes minor*, var. *cati*: an ovigerous female, seen from above; magnified one hundred diameters.

The Sarcopt of the Camel (*S. scabiei*, var. *cameli*) has the integumentary markings less marked than they are in the other varieties. The length of the ovigerous female is ·44 mm., and that of the male ·24 mm., while the former is ·33 mm. broad, and the latter ·16 mm. (?). It causes the mange of the Dromedary, Llama (P. Gervais), Giraffe (Mégnin), and the Bubalis Antelope (Railliet).

The Sarcopt of the Dog (*S. scabiei*, var. *canis*) has been found on several occasions by Railliet and Cadiot, as well as by ourselves, on mangy dogs. It is distinct from the varieties *suis* and *lupi*, which are also sometimes met with on the Dog. Its dimensions are slightly greater than the following, which are those of the Sarcopt of Man (*S. scabiei*, var. *hominis*): Length of chitinous, igerous female ·30 mm., male ·20 mm.; breadth of former ·26 mm., of of three spindl. Sarcoptes of exactly these dimensions have been seen on the is retrodorsal. 1 and by Mégnin.
suckers; the fourth the Capybara (*S. scabiei*, var. *hydrochœri*), which Mégnin and in the female the ferret, has nearly the same dimensions as that of the instead of a sucker. measures ·36 mm. long, and the male ·22 mm., ·30 mm., and that of the male ·16 mm. It

The *Sarcoptes* live on Man et. and by their presence cause the de

The diverse varieties of Sarcoptes are not localized on a determinate species of Mammalia, for several may pass from one to the other, as will be shown hereafter when studying the scabies they determine.

The sub-genus *Notœdres* (Railliet) may be distinguished by its dorsal surface, which is garnished with spines, and sometimes with soft scales, and more particularly by the position of the anus, which is situated on the dorsal surface, near the posterior border in the male, and on the posterior quarter in the female.

Only one species lives on the domestic mammals. It is the DWARF SARCOPT (*S. minor* Fürst.; *S. cati* Hering; *S. notœdra* Delafond and Bourguignon). The body is nearly spherical; the dorsal folds of the integument are disposed in a circular manner, become confounded with each other, form large blunt ridges, and encircle the anus. There are two hairs longer than the rostrum on the epistome, instead of the prickles. The six anterior spinules are arranged in a curved transverse row, the convexity turned forward. There are twelve spinules instead of fourteen, eight being arranged symmetrically in a transverse curved line, parallel to the preceding, in proximity to the anus, and four in two pairs near the borders of the anal slit. There is a pair of short anal bristles. The arrangement of the ambulatory suckers is the same as in *Sarcoptes scabiei*.

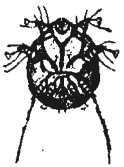

FIG. 74.—*Sarcoptes minor*, var. *cati*: male, seen from below; magnified one hundred diameters.

The dwarf Sarcopt lives on the head of the Rabbit and Cat. It is very variable in dimensions; that found in mange of the Cat and Rabbit is, for the ovigerous female, ·16 mm. to ·25 mm. long, and for the male ·12 mm. to ·18 mm., the width being for the former ·13 mm. to ·20 mm., and for the latter ·09 mm. to ·14 mm. According to Mégnin, the fecundated female does not burrow in a linear channel, but excavates for itself a veritable sub-epidermic nest.

Psoroptes.—The *genus Psoroptes* only contains a single species—the **Ps. communis** (Fürst.; *Psoroptes longirostris* Még.). It is recognised by the characters given for the genus (p. 113). In addition, the following should be noted:

The presence of bristles relatively constant in length, five placed symmetrically on each side of the dorsal surface; some similar bristles, though few in number, on the ventral surface and on several segments of the legs. The *male* has triangular abdominal lobes furnished with five bristles, the three terminal ones being the largest; the first three pairs of legs are complete, but the fourth pair are very short, and have no suckers. In the *ovigerous female*, the lips of the vulva are much plicated, and the commissures rest on two arched pieces, which are divergent and directed backwards. There is a sucker on all the legs except the third pair, which are terminated by two long bristles. The *pubescent female* is recognised by her smaller size, the large vulvo-anal slit, the absence of a sub-thoracic vulva and of the sucker on the fourth pair of legs; in addition, beneath the dorsal surface, and on each side of the posterior commissure of the cloacal slit, are two hemispherical prominences (copulatory tubercles) which assist in copulation by being received into the copulatory suckers of the male. The *nympha* has not these tubercles. In the *larva* the legs of the third (last) pair terminate by two bristles.

The common Psoropt does not make sub-epidermic galleries like the Sarcopt; it lives, in society, among the crusts which it forms by pricking the skin of its host. It produces special dermatoses on the Horse, Ox, Buffalo, Sheep, Goat, and Rabbit. Here, again, the difference of habitat coincides with the existence of varieties, which are scarcely distinguishable from one another by their size and unimportant details, but which, according to their hosts, are designated by the names of *Psoroptes communis equi*, *Ps. c. bovis*,

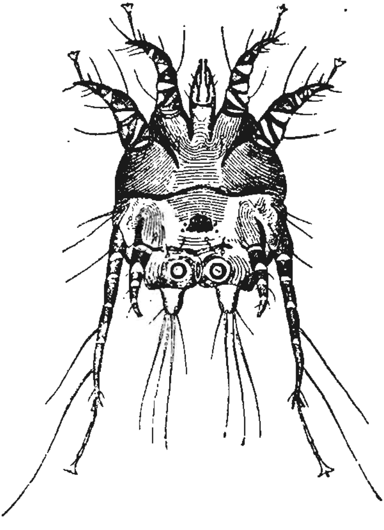

FIG. 75.—*Psoroptes communis*, var. *equi*: male, seen on the ventral surface; magnified one hundred diameters.

Ps. c. ovis, and *Ps. c. capræ*, and *Ps. c. cuniculi*. Their average dimensions are: for the ovigerous female ·65 mm., and male ·48 mm. long; and for the former ·40 mm., and latter ·30 mm. broad. Otherwise, in the absence of information as to their source, there are no special features which will allow one variety to be certainly distinguished from another.

Chorioptes.—This genus contains two species, both parasites of the domestic animals: the **Choriopt Symbiot** and the **Auricular Choriopt.**

Chorlopt Symbiot (*Chorioptes symbiotes* Verheyen).—This has on the middle of the back a wide, granular, chitinous band, twice as broad behind as in front, with its borders concave outwardly, and extending from the margin of the epistome to the point of origin of the second pair of legs. Behind each of the two posterior angles of this band is a short hair, and behind, but near it, are two long bristles; there are several other hairs which, though constant, vary in number, length, and situation according to the sexes. The *male* has rectangular abdominal lobes, carrying four bristles at their extremity—one ordinary, external, round, and free; three grouped at their base, one of them being similar to the preceding, the two others lie on each other and are widened to form a thin foliaceous membrane. The four pairs of legs are pro-

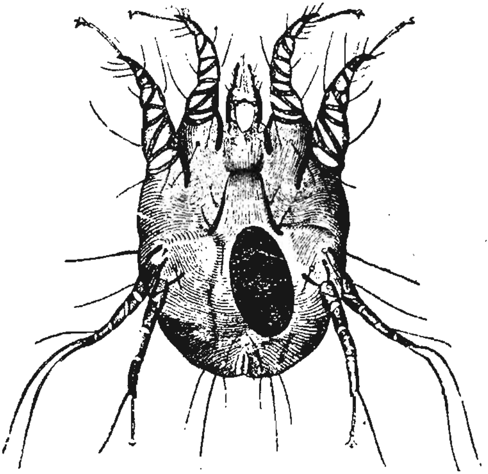

FIG. 76.—*Psoroptes communis*, var. *equi*: an ovigerous female, seen on the ventral surface; magnified one hundred diameters.

vided with suckers; the fourth pair are thin and short. The *ovigerous female* has the lips of the ovulating vulva very much plicated, and in contact, by their commissures, with two pieces similar to those of the ovigerous female of the *Psoroptes communis*. It has a sucker on all its legs, except the third pair, which are terminated by two long bristles. The *pubescent female* differs from the preceding by the same peculiarities as in the *Psoroptes communis*; and the same observations apply to the *nympha* and the *larval hexapod*. The length of the ovigerous female is ·36 mm. to ·40 mm., and the male ·28 mm. to ·32 mm., while the breadth of the former is ·23 mm. to ·26 mm., and the latter ·21 mm. to ·24 mm.

The Chorioptic Symbiot lives in the same manner as the common Psoropt—in colonies, and without excavating sub-epidermic

galleries. It causes a localized scabies, the extension of which is slow, and which is more particularly observed on the Horse and Ox; but it has also been witnessed on the Goat, Sheep, and Rabbit (?). The varieties *equi, bovis, capræ, ovis,* and *cuniculi* (?) might again be distinguished here.

The **Auricular Chorioptes** (*Ch. cynotis* Hering; *Sarcoptes auricularum* Lucas and Nicolet) differs from the preceding species principally by the absence of the abdominal lobes in the *male*, which are represented by two small round projections separated by a notch, each of them having three bristles, the middle one of which is very long. The *ovigerous female* has no suckers on the

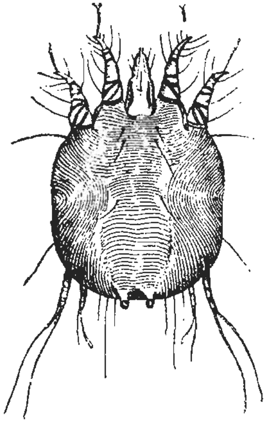

FIG. 77.—*Psoroptes communis*, var. *equi*: pubescent female, seen on the ventral surface; magnified one hundred diameters.

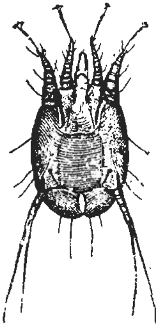

FIG. 78.—*Psoroptes communis*, var. *equi*: hexapod larva, seen on the ventral surface; magnified one hundred diameters.

two last pairs of legs, and the fourth pair of legs are rudimentary; while the *pubescent female* has the fourth pair of legs reduced to simple knobs carrying one hair each. The length of the ovigerous female is ·42 mm. to ·49 mm., and the male ·30 mm. to ·34 mm.; the breadth of the former being ·29 mm. to ·31 mm., and of the latter ·23 mm. to ·28 mm.

This species lives in the auricular concha of the Dog, Cat, and Ferret, and gives rise to a disease which is very remarkable because of the nervous disturbance accompanying it.

The foregoing zoological remarks will suffice to determine the genus and species of the Sarcoptinæ that are likely to be met with. For this purpose, great assistance will be afforded by a

knowledge of the host which furnished the parasites, and the character of the lesions they have produced—that is, by the study of the different forms of scabies.

General Nosography.—The various domesticated animals may serve as hosts to the Acarina of one, two, or three genera of Sarcoptinæ. By their pricking, and, no doubt, also by the irritant

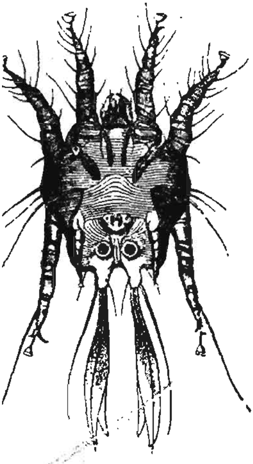

FIG. 79.—*Ch. symbiotes*, var. *equi*: male, seen on the ventral surface; magnified one hundred diameters.

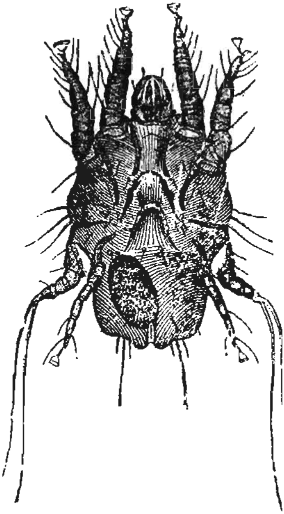

FIG. 80.—*Ch. symbiotes*, var. *equi*: an ovigerous female, seen on the ventral surface; magnified one hundred diameters.

saliva they discharge, these parasites excite an alteration in the skin which is manifested by redness, loss of hair, thickening, effusion, crusts, and an intense pruritus.

The redness can only be perceived on skin destitute of pigment, and then it is one of the most marked signs of the disease. The thickening is little observable at the commencement, but it gradually increases because of the continued irritation of the parasite

and the energetic friction which the animals apply to it under the influence of the pruritus. In some parts—as the extremities, where the skin is thick and covers only a small amount of connective tissue—it becomes augmented in thickness; but where the skin is thin, movable, and only slightly adherent—as on the face, neck and shoulders, sides, etc.—it forms thick folds and deep ridges, which give the animal an altogether peculiar physiognomy. The

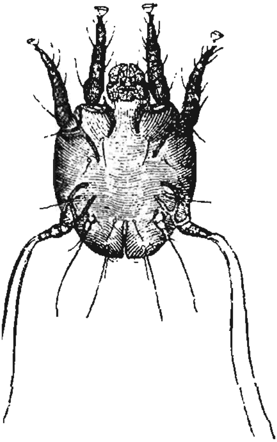

FIG. 81.—*Ch. symbiotes*, var. *equi*: pubescent female, seen on the ventral surface; magnified one hundred diameters.

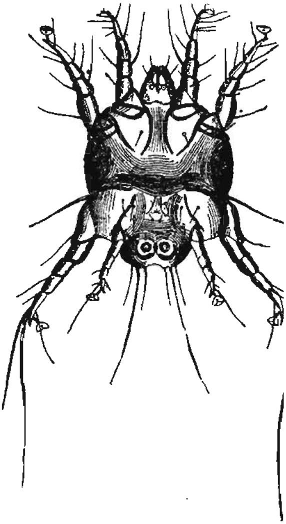

FIG. 82.—*Auricular Chorioptes* of the Dog: male, seen on the ventral surface; magnified one hundred diameters.—Railliet.

bottom of the ridges is moist and often excoriated; the majority of the hairs, if not all, are removed by the rubbings and the morbid process; and at the same time the secretions of the superactive and altered skin lead to the formation of crusts which are irregular in shape, thickness, and distribution, and are composed of serum, dried blood, epidermic *débris*, hairs, etc.

The pruritus, which contributes so much, by the frictions it pro-

vokes, to produce this alteration in the skin, is of variable intensity, according to the temperament of the affected animals, the seat and extent of the disease, and the time of day. It is particularly intense during the night, causing loss of sleep and rest, which, added to the restlessness during the day and the disturbed cutaneous functions, induces debility and emaciation, and leads to marasmus when the malady has been widely extended.

The characters of scabies are more particularly subordinate to the kind of parasite producing it. In this respect it is difficult to

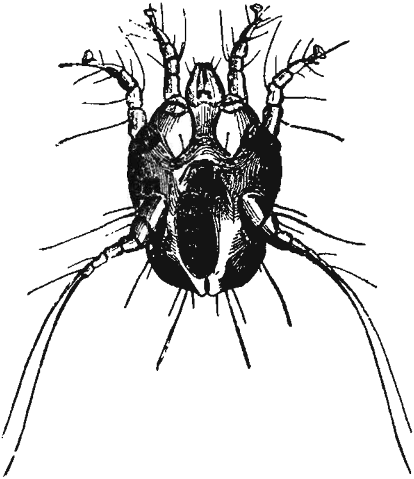

FIG. 83.—*Auricular Choriopt* of the Dog: an ovigerous female, seen on the ventral surface; magnified one hundred diameters.—Railliet.

establish any general rules, as we do not find between the Psoroptes and the Chorioptes differences in habits analogous to those which separate the three sub-genera of Sarcoptes. That which especially characterizes the latter is the fact that the ovigerous female, immediately after fecundation, excavates in the substance of the epidermis a gallery or furrow (*cuniculus*), in which it deposits its eggs; consequently, it happens that sarcoptic scabies offers a greater resistance to the action of curative agents.

Other differences belong to the seat preferred by the parasite.

There are scabies which may appear on all parts of the body; others that always commence at the same points and extend to other regions; and others, again, which are very localized. All these differences will be indicated in their place.

An essential element in diagnosis being the detection of the parasite, care should be devoted to this. But sarcoptic scabies offers the greatest difficulties in this respect. The following recommendations, given by Mégnin for the scabies of the Horse, are equally applicable for all the other domestic animals.

When the weather is cold or windy, it is difficult to find the Sarcoptes, and to be successful in the search it is best to have calm weather and sunshine, to which the mangy Horse should be exposed. After about an hour of this exposure, the crusts and *débris* are collected from the diseased parts; but one must not be satisfied with the crusts that are most easily removed, for on them may be found nothing more than some larval hexapods which have a more superficial habitat than the adults. To obtain the latter, it is necessary to scrape the surface to the blood, through the entire thickness of the epidermis, with a sharp or slightly blunt instrument. Amongst Horses equally mangy in appearance, some will be found which do not nourish nearly so many Sarcoptes as others; and the inverse is equally true, for lymphatic Horses which have the thickest and most abundant crusts have fewest parasites, while Horses of a nervous, wiry temperament have them in largest numbers. It is, of course, understood that it is only on mangy Horses which have not been submitted to any treatment that a search for the parasites is likely to be successful; for it often happens that with those which have been treated, the scabies has disappeared, and in its place is a chronic or artificial lichen if the treatment has been too energetic.

When a good quantity of crusts has been collected, these are put in a well-heated box, and if possible at a window exposed to the sun—for without this precaution the Sarcoptes will remain motionless, and can only be distinguished with difficulty from the dust in which they lie. A small quantity of this dust is spread on a glass plate, and examined under the microscope by a power of 40 or 50 diameters—direct, and not reflected light being employed. Under the influence of sunlight, the Sarcoptes can be seen disengaging themselves gradually from the masses of dust or crusts covering them; then with the point of a needle they are carefully isolated from the foreign matter surrounding them, and lifted by the needle or a fine brush on to a drop of glycerin on another glass. After placing over them a cover-glass, but without compressing them, they may be studied alive, in their true form, and magnified to any size—that of 150 to 300 diameters to examine the general conformation, and from 400 to 500 diameters for details of structure.

A procedure that avoids loss of time and patience, as well as

error, consists in immersing the crusts for an hour or two in a 10 per cent. solution of potash, and then examining them; when it will be found that they have become diffluent and colourless, are easily spread out under the cover-glass, and the Sarcoptes, whose skin resists the alkaline solution, can then be very readily seen. We have many times succeeded in this way, after failing in every other, notwithstanding all our perseverance.

By reason of their relatively greater dimensions, the Psoroptes and Chorioptes are readily found, even by a hand-glass, among the crusts, where they can be seen moving.

With regard to the *ætiology* of scabies, it is needless to refer to the hypotheses found in ancient medicine to explain its genesis. It is to-day beyond dispute that for an animal to have the mange, it must have received the contagium—the acarus—from another mangy animal with which it has been in immediate or mediate contact.

Numerous experiments have established that fact, so far as animals are concerned; on every occasion on which an outbreak of mange has been traced to its source, it has been ascertained that it was introduced by a mangy subject; in every case a psoric Sarcoptid can be found; the means which cure the mange also destroy the parasite; lastly, direct experiment confirms the doctrine. Hertwig has inoculated animals—by friction and by puncture—with serum from the vesicles, with pus, and with dry and dissolved crusts, and yet failed to produce mange. On one occasion, when he neglected to assure himself that the products with which he inoculated did not contain ova or acari, a psoric eruption resulted. Hering tested these experiments, and came to the same conclusions as Hertwig; and Delafond and Bourguignon, as well as Gerlach, arrived at identical results. The constant correlation between the Acarina and the psoric eruption cannot therefore be disputed.

It is not the movement of the parasites which causes the irritation and the pruritus. The Sarcopt is not felt when it wanders on the surface of the skin, nor yet when it is burrowing into that membrane. What induces the itching is an irritant principle deposited by the parasite in the living portion of the integument. Bourguignon has obtained a vesicular eruption by inoculating crushed acari, or the fluid derived from them; and he therefore justly concluded that the animalcule secretes an acrid matter which it insinuates into the skin. But he erroneously believed that this matter, when absorbed, would produce a general eruption. It is a long time since Hertwig practised transfusion of blood from a mangy to a healthy animal of the same species, without result; and it is well known that when a Sarcopt is placed on the skin of Man, the papule and vesicle appearing soon after always correspond to the precise point of the integument pierced by the animalcule.

Gerlach has given a complete demonstration of the purely local

effects of the matter secreted by the acarus. With a very fine needle he traced a groove in the epidermis, and then moistening the point of the instrument with fluid from the crushed parasite, he reintroduced it into the epidermis, but only experienced a vague sensation; but when the point of the needle reached the derma, there was instantaneous pain, succeeded by a papule and a vesicle, with pruritus. By this mode of procedure, Gerlach satisfied himself that the Psoroptes secrete the most acrid fluid, then the Sarcoptes, and, lastly, the Chorioptes.

All these facts thoroughly establish the predominating, essential, and exclusive part the parasite plays, locally and specifically.

Ought there to be admitted, besides this, a predisposition — if not necessary, at least favourable—to the development of the disease? Delafond and Bourguignon, in particular, have replied to this question in the affirmative; their observations were in relation to the scabies of Sheep. With regard to the Horse and other domesticated animals, it is true that weak, badly nourished, dirty, and neglected creatures are more frequently attacked than those in the opposite conditions. But this is only owing to the unclean state of the animals themselves—to the filthy litter, coverings, harness, and insufficient grooming. The parasites, being left in almost absolute tranquillity, can multiply at leisure, and the mange extends gradually on the same animal, or from an affected to a healthy one—not because of its constitutional weakness, but rather because of its unsanitary condition and the natural course of contagion; and to these circumstances must be attributed those epizoötics of mange which usually occur during wars among great agglomerations of Horses.

The *treatment* of scabies consists in the employment of *acaricides*, which act by reason of their toxic properties on the Sarcoptinæ. They are extremely numerous and varied.

In choosing them we are guided by the kind of scabies which is to be treated, the nature of the affected animal, its species, age, size, and susceptibility; as well as the resources at our disposal, and especially the particular activity of the remedies.

In the following table, Verheyen has given interesting indications with regard to the principal agents tried and their acaricide powers. They are principally the result of the researches of Walz, Hertwig, Reynal, Mathieu, and Gerlach, which consisted in putting the animalcules in contact with the various substances, and noting, by means of the microscope, the moment when death occurred.

	DURATION OF LIFE.	
	Hours.	*Minutes.*
Creosote, benzine, and naphtha	..	¼ to ¾
Preparations of these materials	...	2 ,, 5½
Juice of tobacco from the manufactories	..	¼ ,, 1
Solution of caustic potash (1 to 24)	..	2 ,, 2½
Empyreumatic oil	..	3 ,, 4
Oil of turpentine and petroleum	..	5 ,, 9

	Duration of Life. Hours.	Minutes.
Diluted sulphuric acid (1 to 24)	..	7 ,, 8
Tar	..	8 ,, 13
Ferro-arsenical solution of Tessier	..	7 ,, 25
Decoction of tobacco (1 to 5)	..	10 ,, 20
Solution of chloride of lime (1 to 30)	..	15 ,, 30
,, of sulphide of potassium (1 to 10)	..	15 ,, 30
,, of corrosive sublimate (1 to 46)	..	15 ,, 45
,, alumino-arsenical of Mathieu	..	16 ,, 65
Soft soap	..	30 ,, 60
Phosphuretted oil	1	..
Saturated arsenical solution (1 to 6)	2 to 3	..
Double mercurial ointment	4	..
Decoction of black and white hellebore (1 to 16)	6 to 36	..
Walz's wash	6 ,, 48	..
Liniment of sulphide of potassium (1 to 10)	10 ,, 20	..
Infusion of henbane and belladonna	12 ,, 16	..
,, of digitalis purpurea	24 ,, 36	..

An absolute signification cannot be accorded to these figures, the experimental resistance of the Acarina being, in fact, subordinate to their vitality at the moment of testing. Von Schröder, by analogous researches, obtained somewhat different results from the above.

As a general rule, treatment should be preceded by complete removal of the coat from the whole of the body, unless the disease is strictly localized, in which case partial clipping may suffice. Then there should be general washing, by means of a coarse brush, with alkaline or soapy water. Then the selected remedy is applied. In four or five days afterwards the washing and dressing are to be repeated, in order to destroy the Acarina recently from the eggs, which the first treatment may not have reached. If there is emaciation and tendency to cachexia, the food should be substantial and abundant.

The following sketch, which is conformable with the conditions of practice, deals successively with the different kinds of mange in all the domesticated Mammalia; but for the present no reference is made to the auricular acariases due to the Psoroptes or Chorioptes, as owing to their very localized seat, their symptoms, and their lesions, they are distinct from the psoric acariases, properly so called, and also because, from the plan of this work, their place is indicated among the parasitic diseases of the sensory organs.

A.—Scabies of the Equidæ.

The Horse, Ass, and Mule are affected with three kinds of scabies: 1. *Sarcoptic* scabies, due to the *Sarcoptes scabiei* (variety *equi*); 2. *Psoroptic* scabies, due to the *Psoroptes communis* (variety *equi*); 3. *Chorioptic* scabies, due to the *Ch. symbiotes* (variety *equi*). These different forms have been chiefly observed on the Horse.

1. *Sarcoptic Scabies.*

This form of scabies is probably that which authorities have described as the *dry mange* (*gale sèche* La Guérinière), *symptomatic mange* (*gale symptomatique* Huzard, jun.), *epizoötic mange*, etc. Our knowledge of its nature —that is, of the discovery of the Sarcopt which causes it—is due to Delafond and to Gerlach, who, about the same time—1856—found it upon the Horse, and gave a description of it. The epizoöty that prevailed among the Horses of the French army during the war in the Crimea may certainly be ascribed to this parasite, though it was then attributed to misery, privations, bad forage, etc. The same observation has been made after the war (Franco-German) of 1870 and 1871. The Horses and transport animals—Mules and Camels—of the British army in the Crimea equally suffered from 'mange,' which was recognised as such by the veterinary officers (Fleming).

Symptoms.—The first sign of the disease is pruritus. The animal seeks to rub itself everywhere; it bites itself wherever it can reach, and appears to enjoy, and even seeks, the contact of the currycomb during grooming, leaning towards the groom as if to accentuate its desire. If scratched by the fingers, it manifests its pleasure by very characteristic movement of the nose and upper lip, and this is a provisional means of assuring one's self of the existence of the disease, as well as of the reality of its being cured. This pruritus is greater at night than during the day, in warm than in cold weather, in the stable than out of it, when clothed than unclothed.

An attentive examination of the skin will reveal the presence of the mange papules at the pruriginous parts. When the hand is passed over the surface of the skin, slight prominences or granules are felt, which are formed of a little crust around one, two, or three hairs; this is easily removed by the finger-nail, and then there is left in its place a red, moist, denuded surface about 2 mm., or sometimes 4 or 5 mm. in diameter. At other points, mixed with the crusted patches, are slightly salient papules which are scarcely visible—this is the first degree of the preceding lesion, the papule raising its epidermis by a serous effusion that gradually dries and forms a crust. In the earlier stage these small lesions are disseminated; they bring about the fall of the hairs in small, nearly circular patches, which are multiplied and extended, and finally become confluent, forming large dry patches covered with epidermic débris and sparse thin crusts. It is very rare that any vesicles are seen, as their duration is very ephemeral, the friction caused by the pruritus quickly replacing them by crusts.

The depilated patches extend and, by a rapid generalization, finish by invading the entire surface of the body except the limbs. The animal then presents a particularly miserable appearance. The brilliancy of the coat has vanished; large patches with sinuous borders, dusty and greyish in colour, uneven and crusted—often bleeding—on the surface, impinge on the yet hairy portions. A particular feature is the limit of the patches, which is always undecided; and in the adjoining parts, which at first sight appear to be healthy, the initial lesions of the malady are recognised.

The skin becomes considerably thickened, and in the regions

where it is attached to the subjacent parts by a loose connective tissue, it is raised into hard, thick folds; these are more especially observed about the neck and shoulders. Friction is a very important agent in bringing about the alterations in the skin; it excoriates the papules, accelerates the formation of the crusts, produces subcutaneous infiltrations, hæmorrhagic exudations, pustules, fissures, and ulcers.

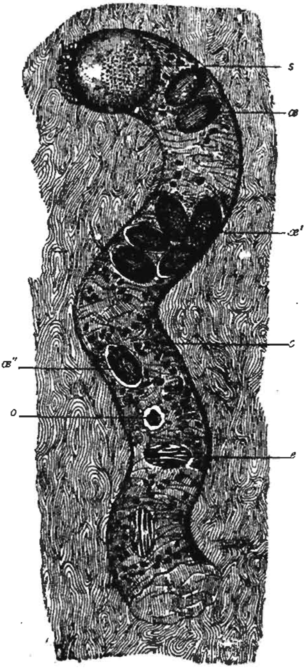

FIG. 84.—Sarcopt of Man.

A fecundated female (*s*) forming its gallery or burrow. A semi-diagrammatic figure, partly after Gerlach. From before to behind are seen the eggs increasingly older, *æ*, *æ'*, *æ''*, then some empty egg-cases, *c*; *o*, opening for the escape of the larva; *e*, excrements.

Besides the pruritus and the eruption, a third symptom—and the most important, as it is the only pathognomonic one—is the presence of the Sarcoptes. The nymphæ, and the adult males and females, are met with among the crusts on every part attacked. The young larvæ and the ovigerous females live in the intra-epidermic galleries or grooves which, in Man, are indicated by a fine red line, from 10 mm. to 20 mm. long. These galleries are not visible in the Horse, because of the pigmentation of the skin and the thickness of the epidermis. They are excavated by the female immediately after copulation; and they are rapidly formed, for in from 15 to 30 minutes the work is completed, and all the more promptly if the temperature be elevated. It is for this reason that these parasites have been considered as noctambulant; if they torment animals more by night than by day, it is because then the conditions of temperature—warm stable, litter, and probably clothing—are more favourable. At the point where the Sarcopt penetrates, an

inflammatory papule forms, but the parasite is not to be found beneath it, but at the other extremity of its gallery.

The female lays its eggs in this gallery, one after the other, and here they are seen mixed with excrements. The larvæ which issue from them are nourished in the gallery for some time, and may even undergo moultings before making their exit by the small orifices which are seen along the course of the passage, and which were believed to be air-holes.

It is not certain whether the nymphæ and pubescent females also live in the galleries. In any case, copulation takes place beneath the crusts and the epidermic scales; it is of short duration, and the males are relatively few, their proportion being estimated at only 5 or 6 per cent. of the total number.

The habits of the Sarcoptes explain the greater tenacity of this form of scabies, as well as its more rapid extension—from the fact that the parasites escape ordinary causes of destruction—and the difficulty in finding them. The latter object can be achieved by the procedure indicated at p. 124. It is rarely necessary to resort to that recommended by Gerlach—transferring the acari to a Man, and then searching for them on him. To do this, the experimentalist places on his arm some of the crust from the suspected animal, fixing it by means of a piece of tissue paper covered by oiled silk or a silk ribbon. In about twelve hours the Sarcoptes have penetrated the skin, and on removing the crusts they can be seen as white points beneath the slightly congested membrane, or on a papule, and they may be seized by means of a fine needle. If we wait until the papule becomes a vesicle, the acarus is no longer there, as it has traced its gallery. This diagnostic procedure does not cause any inconvenience, as a little oil of turpentine or any other acaricide will avert contagion.

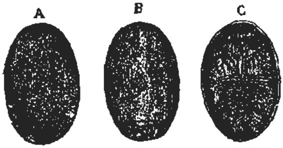

FIG. 85.—Egg of the *Sarcoptes scabiei*, in various stages of development; magnified 150 diameters.

Course, Duration, and Termination.—Sarcoptic scabies is somewhat slow at its commencement; so that it may remain unperceived for some time. A small number of acari do not give rise to anything very marked during the first fifteen days of their installation, and it is only during the succeeding fifteen days that the phenomena of invasion are manifested, although they are still sufficiently vague to make diagnosis doubtful. The affection is more clearly revealed in the course of the third fortnight, and during the fourth it has made more progress than in the previous six weeks (Gerlach). Nevertheless, when circumstances are favourable, the extension of the disease may be at least twice as rapid, and the incubative period be reduced to fifteen days. It would

seem, therefore, that the prosperity of the colony is absolutely conformable to the geometrical progression of the multiplication of the parasites, as given by Gerlach. When the disease is well established on an animal, it may within eight days have reached parts of the body the most distant from where it commenced.

Sarcoptic scabies begins most frequently at the withers, and extends to the sides of the neck, shoulders, back, and sides. It does not easily invade the extremity of the limbs, and it respects the parts covered with strong hairs—crest, tail, legs—which remain with their hairy covering in the midst of neighbouring denuded regions. The Psoropt, on the contrary, appears to seek those parts avoided by the Sarcopt. Sometimes, though rarely, sarcoptic scabies commences at the head, flanks, croup, etc., this depending upon the initial point of contamination.

When the disease is not interfered with, by the disturbance in the functions of the skin and the restlessness due to the pruritus, it occasions a serious alteration in nutrition and marked marasmus that may, though slowly, lead to a fatal termination. Such a result, however, is only witnessed among animals which have not received sufficient attention; and as diseased animals are not the objects of careful observation, and as nearly always the malady is interfered with in its course by more or less judicious treatment, there is no reliable information with regard to the minimum, average, or maximum duration of this kind of scabies.

On a Horse which has been recently cured of mange, the hairs grow unusually fast, owing to the greater activity of the capillary circulation of the skin; they are longer than the neighbouring hairs that remained healthy and were clipped in treatment, while their colour is generally darker; this difference persists until the next shedding of the coat.

Etiology, Contagion.—Experiments and observations demonstrate the contagiousness of sarcoptic scabies from the Horse to other Horses, Asses, or Mules, and reciprocally. This transmission takes place in every way by which the parasite can be transported, and principally by litter, rugs, grooming, utensils, walls of stables and partitions of stalls. It also occurs, though less frequently, by direct contact of diseased with healthy Horses. The mange which prevailed among the French army Horses in the Crimea made startling progress during the voyage, owing to their being so closely packed in the transports; and here we have a proof of the direct transmission of the Sarcoptes, all the Horses having been attacked with the malady on the parts where they came into contact with each other (Delafond and Bourguignon).

The danger of contagion is related to the phase and intensity of the disease. At the period of their installation, the Sarcoptes have little tendency to emigrate, and cohabitation of healthy Horses with one which is just infected is often followed by no bad results; but after the formation of scales and crusts, the parasites pass quickly from one Horse to another, a slight and fugitive contact

between them being sufficient to ensure infection. Gerlach asserts that he has seen Horses in good health, placed alongside mangy horses covered with crusts, contract the disease in a quarter of an hour.

The larvæ and nymphæ, and the young males and fecundated females, are more especially the active agents in transmitting the malady. The egg-laying females, concealed in the galleries, scarcely concur in this transmission, unless they are violently exposed by energetic scratching which reaches the blood.

With regard to the persistency of contagion by articles from mangy animals, which harbour the Sarcoptes, Gerlach on the one side, and Delafond and Bourguignon on the other, have made interesting experiments as to the vital tenacity of the parasites.

According to Gerlach, no variety of the Sarcopt exposed to a dry heat of 60° (Cent.) can live beyond an hour. Kept in a watch-glass, the Sarcopt of the Horse died on the fifth or sixth day; with the crusts, it lived eight or ten days; and in an inhabited stable, death only took place on the twelfth to the fourteenth day. On a fragment of skin covered with crusts, and exposed to heat, the Sarcopt perished when the piece was completely dried, which was on the ninth day; when the skin preserved its humidity, the animalcule gave feeble signs of life on the twenty-fourth day, but these had entirely ceased on the twenty-eighth day.

Delafond and Bourguignon have obtained similar results.

The Sarcopt of the Horse being only a variety of the *Sarcoptes scabiei*, it is well to know if the Horse can contract sarcoptic mange by mediate or immediate contact with any other of the Mammalian species susceptible of being affected with a similar form of the disease.

So far as the scabies of Man is concerned, Delafond and Bourguignon have, on different occasions and in the space of forty days, deposited on the skin of an old and feeble Horse 176 Sarcoptes obtained from persons affected with itch. These parasites attacked the skin, buried themselves in the epidermis, and produced a papulo-vesicular eruption on the shoulders and neck. The Horse died on the fourteenth day, and at the autopsy it was impossible to find any of the parasites on the skin. In another experiment, 187 Sarcoptes, collected from affected Men, were deposited at several times within twenty-six days on the side of the neck of an old lean Horse. They traced numerous galleries and occasioned a vesicular eruption; but this disappeared, and on the animal being clipped on the seventy-ninth day, there was no evidence of scabies or parasites. These experiments demonstrate that the Sarcopt of Man will only temporarily implant itself on the skin of the Horse, and that there is nothing to fear from Men suffering from itch attending Horses.

We cannot be so certain with regard to the transmission of the Sarcopt of the Dog to the Horse. In three experiments made by Delafond and Bourguignon, great numbers of the Sarcoptes of the Dog—110, 58, and 220—were placed on the skin of two Horses; they attacked the integument, raised the epidermis, and made galleries; living for twenty to twenty-four days, they occasioned a

secondary eruption, accompanied by the majority of the symptoms of mange; but they eventually died, and the symptoms spontaneously subsided.

Gerlach has also made some attempts at transmission, which have likewise yielded undecisive results. He believed, however, that an emigration *en masse* of the Sarcopt of the Dog might give rise to a transient eruption on the skin of the Horse; and he thought that to this cause might be attributed the mange contracted by horses—according to the statements of hunting-men—when mangy Foxes, killed in the chase, are thrown over the backs of their steeds.

It is also interesting to note the fact of the transmission of mange from the Lion to the Horse, as observed by Delafond and Bourguignon. Five Lions in a menagerie were affected with sarcoptic scabies. The brush and sponge employed to clean their skin were used for some days in grooming six Horses; in about seven to nine days afterwards, the latter had a very pruriginous papular eruption on the croup, back, shoulders and chest, and in the crusts collected from them were found the Sarcoptes of the Lion. This mange was readily cured by the application of benzine, but it is probable that it would have disappeared spontaneously. Lastly, the sarcoptic scabies of Goats has been transmitted to Horses, in an epizoöty reported by Wallraff.

Communication of the Sarcoptic Scabies of the Horse to other Species of Mammalia.—A. *Man.*—The sarcoptic scabies of the Horse may be transmitted to Man, although this occurrence is comparatively rare. For a long time instances have been recorded—long before the three kinds of Horse mange had been distinguished. The greater portion of the following résumé is taken from Delafond and Bourguignon's work.

Enaux and Chaussier have recorded cases of contagion of mange of the Horse to Man. Chabert asserts that he, as well as several other veterinary surgeons, had caught mange from Horses; and Delabère-Blaine also gives an instance. Chavassieu d'Audebert advanced the opinion that mange may be communicated from the Horse to Man. Barat reported to the Lyons Veterinary School, an instance of several persons having received mange from a Horse. Grognier relates that a mangy Horse had communicated its disease to a number of people who had dressed it before it was sent to the Lyons Veterinary School. Robert Fauvet, an Italian veterinary surgeon, states that a farmer having bought a mangy horse, rode it home, and the day after his arrival he felt a great itching all over his body; the same was the case with his son and a friend who had accompanied him on the journey. The groom to whom he had entrusted the horse, scratched himself very much the second day after he had been grooming the animal. These persons afterwards conveyed the disease to others on the farm, and more than thirty persons were successively attacked. The farmer sold the mangy horse to a miller, who, with his sons, who had touched the animal, were soon after suffering from the itch. The psoric nature of the affection was recognised by distinguished physicians.

Montaut-Laforest reports a case of contagion to Man from a mangy Mule. Lavergne, Carrère, Girou, Sonlé, Grève, Pachur, Hertwig, and Stütz, have published very circumstantial facts in relation to this conveyance of Horse scabies to Man.

Sick mentions an epizoöty of mange in a regiment of Hussars, more than one hundred of the soldiers being infected.

Marrel, a veterinary surgeon at Valréas, Vaucluse (France), was attacked by the disease when treating mangy horses, and saw the same accident happen to a farmer, who communicated the malady to his wife, and she to a child she was suckling; four other children who were attended to by the mother were also infected.

Dupont, veterinary surgeon at Bordeaux, sent on an official mission, reported cases of people being infected with mange from old Horses kept to feed the leeches in the marshy districts of the Gironde.

Ritter reports having been himself, as well as a servant, infected while attending on a mangy Horse.

In 1856, several pupils of the Alfort Veterinary School contracted the itch through operating upon a mangy Horse. This was the occasion on which Delafond discovered that this form of scabies was due to a Sarcopt, which he considered was identical with that of Man. The discovery raised the number of species of psoric Acarina of the Horse to three.

Gerlach, in the experiments on himself and several pupils of the Berlin Veterinary School, has seen the Sarcopt of the Horse fix itself on the human skin, like the Sarcopt special to Man, and cause an itch that was generally fugaceous.

Mégnin has also observed instances of contagion to Man, during the epizoöty of mange prevailing among the Horses of the French army in 1871.

Fleming, in the Crimea, saw a large number of Turks suffering severely from itch, due to their sleeping on the saddles and blankets worn by their Horses, whose skins were covered with mange.

Longchamps informs us that, in 1794, the Horses and Mules of the French army in the South of France were affected with mange to a very serious extent, and that the disease was transmitted to, and propagated among, the soldiers.

Géraud has also published instances, and a great number of others will be found in the thesis of Nérée Got.

All these facts prove that the sarcoptic scabies of the Horse can be transmitted to Man, and also that the parasite does not find a favourable soil for its multiplication, as the itch it produces generally disappears spontaneously in from fifteen days to six weeks; but in any case it readily yields to simple treatment, such as alkaline and sulphur lotions.

A proof of the difficulty of this transmission is also to be found in its rarity, when compared with the frequency of sarcoptic scabies in the Horse. In the epizoötics of mange occurring among the Horses of the French army during great wars, very few cases of the conveyance of the disease to Man have been noted; and if the itch caused serious disability among the soldiers during the Crimean War, it is not clearly established that its origin was due to mange among the Horses, which was the opinion widely prevalent; and though many cases were adduced as being derived from this source, yet the evidence is not so satisfactory as could be desired.

But an exaggerated significance should not be given to this rarity of contagion, for the transmission from Man to Man is not as subtle as is generally believed. 'The itch,' says Besnier and Doyon, 'is not *usually* contracted except by cohabitation—intimate contact prolonged and repeated, and particularly at night; it must not be affirmed that this never happens *accidentally*, but it is sufficient to know that it is exceptional.'

B. *Domesticated Animals*.—Sarcoptic scabies of the Horse appears to be capable of transmission to the bovine species, although up to

the present time no one in practice has observed this form of mange on Cattle. The possibility of this transmission rests on facts published by Robert Fauvet and Grognier, of which mention has already been made. The Horse of Fauvet communicated mange to a Cow which had rubbed its neck against the manger of that animal. The Horse of which Grognier speaks, transmitted its disease to two Cows placed alongside it in the stable.

Beyond these facts, where the sarcoptic nature of mange of the Horse was established by its transmission to Man, but where the equine origin of bovine mange was not sufficiently demonstrated, there are doubts as to the possibility of this transmission.

Neither is there any more authority for stating that Horse mange may be communicated to the Sheep, Goat, Dog, etc.

Diagnosis.—An important element in diagnosis is the discovery of the Sarcopt, with all its characteristics. Sarcoptic scabies differs from *psoroptic scabies,* as we shall see hereafter, by its more rapid generalization, by its more subtle contagion, and by its seat—psoroptic scabies commencing and localizing itself nearly always at the upper part of the neck, towards the forelock and the tail, which become denuded of hair, tumified and wrinkled. Psoroptic scabies also assumes a form in which the patches are better defined, they being tumified at the base, crusted, and more humid.

Sarcoptic scabies differs from *chorioptic scabies* in the latter being confined to the limbs at first, commencing at their most inferior parts, and slowly extending upwards; it is also only feebly contagious.

Otherwise, the three forms of scabies may co-exist, and the remembrance of this important fact may avert grave errors in diagnosis.

At its commencement, sarcoptic scabies is difficult to diagnose from *dermanyssic acariasis*—due to the transference of the Dermanyssus of the Fowl to the body of the Horse. But it is distinguished from it, nevertheless, in the latter disease appearing on Horses which live in the vicinity of poultry-yards and pigeon-houses, in its becoming very quickly generalized all over the body, and in its obduracy to all treatment until the Horses quit the locality, when it is readily cured. Besides the absence of the Sarcoptes, dermanyssic acariasis is also recognised by the small depilations it produces, which, though similar at first to those of sarcoptic scabies, become multiplied, but do not extend by a centrifugal development, like those of mange.

It is difficult to mistake mange for *phthiriasis*, as this only causes slight depilations, while the parasites are very visible; and by the uncleanliness which has permitted their multiplication, mange would have assumed quite another development than the slight lesions produced by the Lice.

When fully developed, sarcoptic scabies looks like *strangles eczema* (*eczema gourmeuse*) and *humid eczema* (*eczema dartreuse*), but in the former there is no pruritus and it runs on rapidly to recovery; while the latter, which is accompanied by the same kind of pruritus as mange, extends only slightly less rapid, becomes chronic, and

assumes a lichenoid form; though there is great difficulty in distinguishing it from sarcoptic scabies when microscopical investigations are without result. But the humid eczema is not contagious, and yields only to internal treatment, while external treatment alone will succeed with mange.

Prognosis.—Sarcoptic scabies is the most serious of the three forms affecting the Horse. It owes its gravity to its great contagiousness—which allows it to assume an epizoötic form—and also to its possible transmission to Man. In itself, it does not cause irreparable injury to the health of animals; but by the debility and anæmia that ensue when it is of long duration, it predisposes to serious diseases which may terminate in death. It also causes great economic inconvenience and loss, as animals affected with it cannot be worked. With regard to its resistance to treatment, this varies according to the condition of the animals suffering from it and the duration of the disease. Young and vigorous Horses in good condition are less rapidly invaded by sarcoptic psoriasis, and are more easily cured, than are old, feeble, and worn-out animals. The disease is also more quickly combated when it is recent; and it is rare that well-directed treatment does not succeed in curing it.

Fleming, from experience derived from army horses during war, found it a most formidable malady to contend with, and one causing somewhat heavy loss, death often ensuing in a wonderfully short time. And even during peace, it not unfrequently leads to a fatal termination when it has been allowed to go on unchecked for a certain period, and especially if the horses are old and weak, or overworked and badly cared for. German authorities also consider it a grave malady. For instance, Friedberger and Fröhner in their classical work—*Lehrbuch der Speciellen Pathologie und Therapie der Hausthiere*—state that the prognosis is more grave than is generally admitted, and that at an advanced stage it is inveterate to all medication, even the most energetic; that nearly always, after months of treatment, relapses occur; and that in chronic cases more or less generalized, the animals become emaciated, fall into a state of marasmus, and may perish from exhaustion.

Pathological Anatomy.—Besides the cutaneous alterations described under symptoms, dissection affords a more exact idea of the lesions accompanying the malady. Delafond and Bourguignon state that, if a fragment of the skin of a mangy horse be exposed to moist heat for 24 to 48 hours, the epidermis can then be removed by means of a fine scalpel and forceps. By a slight magnifying power and direct light, in the parts recently attacked can be seen the furrows or galleries, straight or sinuous, narrow and shallow, more or less near each other, and 2 mm. to 4 mm. in length. At various points they show widenings which are somewhat deeper than the other parts, where two or three eggs are deposited; and at the end of a gallery is an ovigerous female. On

the sides of the furrows the dermal papillæ are red and hypertrophied, and the superficial layer of the derma is infiltrated with a yellow serosity; while in the vicinity of the galleries—and even some distance from them—are vesicles, each formed by an elevation of the epidermis containing a little serum; the papillæ beneath being exposed, are red and infiltrated. Vertical sections will also show these lesions.

At the points where the changes are not so recent, the galleries are distorted and disseminated, and the derma and papillæ are altered to a very high degree; there are numerous elevations and depressions—for the Sarcoptes no longer live in the tunnels, but in depressions beneath the elevated and detached epidermis. The derma is thickened by a sero-sanguinolent infiltration; the lesions extend to the glands of the skin and the hair-follicles, and this explains the shedding of the hair, the dryness of the crusts, and the thickness of the epidermis, the formation of which is irregular.

Lastly, in the parts where the disease is oldest, the skin is indurated and thickened, and the secondary lesions are observed, depending on the cracks, erosions, etc., consecutive to the friction during life. There is nothing particular to note, either with regard to the engorgement of which the limbs may be particularly the seat or of the internal complications which may occur in the disease (Delafond and Bourguignon).

Treatment.—On the first suspicion of mange, the suspected animal should be isolated. When there are several Horses affected, it is well to divide them into groups, according to the period of treatment they have undergone.

In the treatment—in addition to the destruction of the parasites—when the malady is of some duration, the general debility, the consequences of which are especially to be feared, has to be overcome.

a. Treatment is to be commenced by clipping the patients, out of and at some distance from the stable. This clipping always shows that the malady is more extensive than was supposed, and is the only way of reaching all the parasites. The hair should be carefully collected and burned.

b. The body is then subjected to a general lathering with soap and water in the following manner: Two to four pounds of soft soap are smeared over the surface of the body, and rubbed well into the skin, so as to cause it to soften and penetrate the crusts. In an hour afterwards, the skin is scrubbed by means of a brush and tepid water (soft water if possible), and then tepid water is thrown over the body to remove all the soap; the skin is dried by a scraper, followed by straw or hay wisps, which should, when done with, be burned. One lathering generally suffices, but another may be applied if crusts still remain.

c. When the skin is dried, antipsoric remedies are had recourse to. Those which have fatty or oleaginous matters in their composition should not be applied over the whole surface of the body at one time, in order to avoid sudden suppression of the cutaneous

functions. When the scabies is generalized, the dressing should be applied over one half of the body at a time—right or left side, or anterior or posterior moiety — an interval of forty-eight hours being allowed to elapse between the two applications, and then another general lathering after the same period.

Petroleum and benzine are often used, and they are excellent acaricides; but they have the inconvenience of producing irritation of the skin, which continues for a long time, prevents the practitioner easily ascertaining if the disease is cured, and hinders the employment of the animals immediately after recovery. So that there is reason to reject them in practice.

In Germany *creosote* is very much employed, the experiments of Gerlach having demonstrated that it is at the head of all the acaricides, as it causes the death of the Sarcoptes in 15 to 45 seconds. It is used mixed with alcohol and water (creosote and alcohol 10 parts, water 25 parts), or with oil (creosote 1 part, oil 25 to 40 parts), or lard (same proportions). The liquid form is the best. One to three energetic applications, at intervals of three to five days, suffice to effect a cure.

In France, the agents which succeed most rapidly are found to be *tobacco*, *sulphurated potash*, and *sulphur*.

The liquid refuse of tobacco manufactories, in the proportion of 100 grammes to 1 kilogramme of oil, constitutes an efficacious and economical preparation. When a manufactory is not near, and this refuse cannot be procured, tobacco itself must be dispensed with, as it is too costly.

Sulphurated potash in concentrated solution, 250 grammes to the litre of water, acts efficaciously, and is very frequently employed.

The *Codex* gives the following formula, under the heading 'Sulphurous Pomade for the Cure of Mange (Trasbot)':

Solid trisulphuret of potassium - - - - -	10 parts.
Carbonate of potass. - - - - - -	2 ,,
Lard - - - - - - - -	300 ,,

Mix thoroughly.

This is destined to replace the pomade of Helmerich.

Sulphur is used in the form of a sulphur pomade (sublimed sulphur 10, lard 30 parts), or Helmerich's pomade (sublimed sulphur 200, potassium carbonate 100, lard 800 parts). Numerous formulæ have been given for the antipsoric employment of sulphur; but the two preceding, and especially the pomade of Helmerich, are those which merit the preference.

The *Codex* gives the following formula for a mange-dressing:

Benzine - - - - - - -	300 parts.
Oil of cade - - - - - -	100 ,,
Coal-tar - - - - - - -	100 ,,
Soft soap - - - - - -	100 ,,
Oil of turpentine - - - - -	100 ,,

Triturate the soft soap and coal-tar in a mortar, and add the oil of cade; the mixture being perfectly homogeneous, gradually incorporate the oil of turpentine, then the benzine.

In employing these different remedies, the entire surface of the body should be dressed at one time; nevertheless, in using the tobacco there is danger of poisoning, and it is safer to dress only one-half of the body at a time. The preparations of sulphurated potash or sulphur have not this inconvenience, and they are cheap. The medicament is allowed to remain on the skin for three or four days; and then a last washing with soap is made in the same manner as the first. When the medicinal rubbing has been well done, and no part of the body has been overlooked, it is rare to see the itching persist. A most careful repetition of the treatment will most certainly triumph over the disease.

At the Toulouse Veterinary School, the treatment successfully *employed consists in the use of a pomade prepared according to the* following formula, which is almost that of Pujol and Bonnet:

Powder of cevadilla	100 grammes.
Calcined alum	40 ,,
Sublimed sulphur	60 ,,
Olive-oil	1 litre.

Digest for two hours in a water-bath.

In the case of localized mange, the oil of tar is sometimes employed.

For some time, creolin or cresyl has been successfully used in solution, 3 to 5 per cent.; and it is as simple as it is inexpensive.

To prevent the reappearance of the disease, it is obvious that disinfection of the harness, clothing, grooming utensils, and stable is necessary. The best disinfectant is boiling water, the Acarina and their eggs being destroyed at a temperature of 70° to 80° (Cent.). If there is apprehension that this may spoil the harness, it can be disinfected by plunging it into an antipsoric solution of sulphurated potash or creolin.

Internal treatment, which played so large a part in the older medicine, should only have for its object remedying the constitutional debility. Abundance of food, tonics, and good general hygiene are the simple means to be resorted to.

This treatment of sarcoptic scabies does not differ much from that resorted to in England (Fleming). When the skin has been thoroughly washed with soap and water as recommended above, it is soaked for some time with a solution of pot. carbonate and oil, and the parasiticide is then rubbed in, a second dressing being made in about a week. Washing with lead acetate solution relieves the eczema that frequently accompanies mange, while diluted alkaline solutions and oil of eucalyptus abate psoriasis. Chronic inflammatory sequelæ are treated by weak solutions of lead acetate, glycerin and water; with salines, arsenic, and iron salts internally.

2. *Psoroptic Scabies.*

Synonyms.—The *Rouvieux* of the hippiatrists; the *Gale humide* of Le Guérinière; the *Gale par acare* of Huzard, jun.; the *Gale dermatodectique* of Delafond; *Psoroptic acariasis.*

This form of scabies has been the longest known, and is the most common. It affects the Horse, Ass, and Mule, and sometimes prevails epizoötically.

According to Delafond and Bourguignon—who have thrown much light on the history of this malady—like the majority of the forms of psora, the parasite of this form (*Psoroptes communis*, var. *equi*) was observed about the middle of the last century by Lonting; but the first illustration of it was by Gohier and Saint-Didier, and was presented to the Agricultural Society of Lyons in 1813; then came the drawings of it by Bosc in 1816, in the *Dictionnaire des Sciences Médicales*; afterwards those of Raspail in 1833, of Hertwig and Hering in 1835, of Gervais in 1841, of Dujardin in 1843, and of Gerlach in 1857.

Symptoms.—Psoroptic scabies of the Horse may appear on any part of the body except the extremity of the limbs; but it more especially affects the upper part of the neck—at the root of the mane—the poll, and the tail; and as it immediately gives rise to pruritus, attention is often directed at first to the state of the long hairs, which are matted and rubbed. The pruritus has the same characters as that of sarcoptic scabies.

The first alteration noticed is in the form of small papules—which are red on the non-pigmented parts of the skin—from 7 mm. to 8 mm. in diameter, and 2 mm. to 3 mm. high. At their summit the epidermis on these papules is raised by an accumulation of serosity, which quickly causes it to be broken, and from this results a crust, owing to the desiccation of the fluid; but as this continues to exude, the crust becomes thicker in mixing with the epithelial débris, and remains moist and viscid—a feature that distinguishes it from the always dry and furfuraceous crust of sarcoptic scabies.

As each vesico-pustule is the result of the puncture of a Psoropt, and as the parasites live in agglomerated colonies on the surface of the epidermis, these punctures are made near each other and become multiplied as the Psoroptes increase in numbers, until at last they are confluent, and form veritable plates of crusts.

The rubbings that the patient energetically practises against everything within reach contribute to the inflammation of the skin, to the abundance of crusts, and to the formation of sores and ulcers. The crusts themselves—which are naturally of a light-yellow tint—are often red or dark-coloured, from the blood impregnating them. The hairs become uprooted, and fall off during the rubbing or grooming, leaving a smooth, shining, greasy patch. The skin is infiltrated, thickened, and hard, as well as wrinkled where the subjacent connective tissue will permit it to be so. The crusts are agglutinated together, and become more and more abundant, adhering more or less closely to the surface of the derma.

Contrary to the habit of the Sarcopt, the Psoropt seeks the parts sheltered by the long hairs, notwithstanding the thickness of the skin at these points. The progress of the trouble that it excites is important—more by the increasing gravity of the local alterations than by the rapidity of extension of the disease. A large superficies of skin may still remain intact, while serious changes are accumulating in a short time around the primary point of invasion. The regions in which the disease remains at first for a long time localized are the forelock, mane, and base of the tail; then it extends to the submaxillary space, the breast, and the internal surface of the thighs and neighbourhood of the prepuce. It increases by a regular extension, the limits of the patches incessantly growing, but not in the diffuse manner seen in sarcoptic scabies. It may be transplanted by grooming to any part of the body, but its extension is always centrifugal.

The upper part (or ridge) of the neck affected with psoroptic scabies is thickened, infiltrated, marked by large transverse folds, partially depilated, or covered by very short hairs mixed with some long ones; while crusts are extended over them, and in the deep furrows between these folds exudes an abundance of viscid, often fœtid serosity, that, in summer, may contain the larvæ of Muscidæ. This localization of the disease has received the name (in France) of *Rouvieux*.

The presence of the Psoroptes gives to all the symptoms their precise significance. They are always in great numbers at the points invaded, and are readily found beneath the crusts, especially towards the limits of the patches. In examining scrapings from these parts on black paper, by means of a magnifying-glass, or even with the unaided eye, numerous Psoroptes will be seen moving about actively, in all phases of development, and often in a state of copulation (Figs. 65, 75, 76, 77, 78).

Course, Duration, and Termination.—Psoroptic scabies progresses *slowly, and very rarely invades the whole surface of the body*. While at the end of a month the Sarcoptes will have spread to the most distant parts of the skin, the Psoroptes at this time will be still located at the upper part of the neck or base of the tail, where they had established their first colony. No fixed duration can be assigned to this form of scabies, even approximately; but in any case it has no tendency towards a spontaneous cure.

Etiology, Contagion.—It has been already mentioned that of the three kinds of psoric Acarina, the Psoroptes secrete the most acrid fluid, and this explains the intensity of their morbid effects. Psoroptic scabies, like the other forms, can only be developed by contagion; so that there is no occasion to take predisposition into account; and uncleanliness, from whatever cause, can alone play a preparatory part.

Contagion is effected in the same extrinsic conditions as in sarcoptic scabies; it is as much more active as the contagiferous animal is seriously affected.

With regard to the persistency of contagion in articles coming from mangy Horses, the experiments of Gerlach have shown that the vital resistance of the Psoropt exceeds that of the Sarcopt. Removed from its host, it lived from ten to fourteen days in a dry atmosphere, and from twenty to thirty in a stable. Plunged into a state of apparent death, it may yet at the end of six to eight weeks be revived by means of heat and humidity, though it will not recover so much as to be able to puncture the skin. Fecundated females have a greater vital resistance than the males, and the latter than non-fecundated females.

Observation and experiment appear to demonstrate that it is always from the Horse that the Horse receives the original Psoropt that invades it. Gohier vainly endeavoured to transmit the scabies of the Ox to Horses and Asses, and Delafond also failed with the Psoroptes of the Sheep conveyed to the Horse. Nevertheless, if Hosæus has unsuccessfully attempted to transmit the Psoroptes from the ear of the Rabbit to Horses, Mathieu has, in the same conditions, obtained a positive result. On the other hand, facts given by Cagny and by Cadéac would lead to the belief that, in some circumstances, the psoroptic scabies of the Horse may have its origin in the auricular acariasis of the Rabbit (see *Parasitic Diseases of the Ear*).

When placed on the skin of Man, the Psoroptes cause a violent pruritus; but they never give rise to a psoric eruption, and soon disappear. Gerlach could not succeed in transmitting the psoroptic scabies of the Horse to the Sheep and Ox; and Delafond also failed with the latter animal, notwithstanding the apparent identity of the Psoroptes that the Horse and Sheep may harbour. Experiments of transmission made with the Pig, Dog, and Cat have always given a negative result.

Diagnosis.—What has been said with respect to the symptoms of sarcoptic and psoroptic scabies, and the resemblance that has been spoken of when alluding to the differential diagnosis of the former, will enable us to dispense with further reference to this point. The difference between this form and chorioptic scabies has also been sufficiently indicated.

The usual readiness with which the parasite can be found renders diagnosis easy. At the commencement of the affection, its presence may be demonstrated by fixing the crust on the arm of a Man; in one or two hours afterwards a pricking sensation will be experienced in the part, due to the punctures of the parasite.

It should always be remembered that the three forms of scabies may co-exist on a Horse, although simultaneousness of two of the types is absolutely rare. Psoroptic scabies may also be mistaken for *pityriasis*—the principal form of the *Rouvieux* of the hippiatrists—which often affects the upper border of the neck and root of the tail of dirty horses; it also often coincides with phthiriasis, of which it is then only a manifestation. And, besides, it may be distinguished from psoroptic scabies by its chronicity, its slight

tendency to extend, the trifling pruritus, and, above all, by the absence of the Psoroptes.

Prognosis.—Psoroptic scabies is a much less serious affection than sarcoptic scabies. Its extension is less rapid, it is much longer localized, is not so frequently epizoötic, is much more easily combated, and rapidly yields to proper treatment. The skin often retains, for an indefinite time after the disease has been cured, the morbid thickness it had acquired, and many of the hairs are not reproduced.

Pathological Anatomy.—There is nothing particular in the description given by Delafond and Bourguignon of the morbid lesions of the psoroptic scabies of the Horse ; it applies to all the irritations of the skin, and is subordinate to the intensity of these.

Treatment.—The same prophylactic, hygienic, and therapeutic measures are necessary for this form of scabies as for the sarcoptic form. Failure is rare, and the treatment may even be more simple, as it can be limited to the affected parts, or be only extended for a little distance on the healthy skin surrounding these ; while, in order not to disfigure the animal, portions of the hair of the mane and tail can be allowed to remain. On the neck, only the hair in the furrows of the skin is removed with scissors, that on the summit of the ridges may remain. At the tail, transverse cuts are made through the hairs, so as to leave wide lines on the most affected places ; these will allow the air to circulate more readily among the hairs, and so to dry the crusts, rendering cleansing and the application of remedies more easy.

With respect to remedies, these, from motives of economy and in view of limited employment, should have wood-tar as their base ; though this does not answer for sarcoptic scabies, in which, the application being of necessity general, the animal would be exposed to the danger of cutaneous asphyxia. This tar is generally mixed warm with soft soap (2 parts of tar to 1 of soap), and it is rubbed into the patches on the skin by means of a brush, without making the application general. This remedy is only used for common Horses, and, in general, recourse is had to one or another of the remedies indicated for sarcoptic scabies.

3. *Chorioptic Scabies.*

This form of scabies—the *Gale du pied* (of the French), the *Fussräude* of Gerlach—was first described by Gerlach in 1857, and was subsequently studied by Delafond and Bourguignon. It is due to the common choriopt (Figs. 79, 80, 81, 82, 83).

Symptoms.—The disease commences at the fetlocks and pasterns—chiefly those of the posterior limbs. It afterwards reaches the shanks, hocks, and knees, rarely extending to the body or croup. It is indicated by signs of itching, which are much less active than in the two preceding forms, and are more particularly noticeable during the night, and while resting after work. The Horse stamps,

rubs one leg against the other, endeavours to bite the limbs, and kicks. Such horses are often very troublesome to shoe, as they try to rub the affected leg while the shoer is holding it up, and therefore he is much pulled about.

In a variable time—sometimes several months—the region affected is covered by an abundant epidermic desquamation, in the midst of which the Chorioptes are readily discovered; the hairs are shed, and in the parts limiting the depilations they can easily be pulled out in tufts, leaving the subjacent skin bare and smooth. At a later period, the skin becomes thickened and exudes; crusts of variable thickness form, and cracks appear in the hollow of the pastern, which may granulate and become somewhat serious. Coarse-bred, heavy Horses are generally those most liable to become affected, the thick hairy legs affording good shelter for the parasite. The skin is scurfy and the hair much broken and woolly.

Chorioptic scabies follows an extremely slow course, and a Horse must be greatly neglected by its owner, even for several years, before the disease invades the upper part of the limbs and the trunk. It shows itself almost exclusively during the winter—not that the chorioptes abandon their host during the summer, but probably because, during this season, the natural excretions of the skin dispense with the necessity for actively pricking it, in order to excite the exudation of nutritive fluid.

The disease may persist for several years if the Horses are badly groomed. The skin then becomes infiltrated, and cracks more or less deeply in the hollow of the pastern and above the fetlock; in the course of time the papillæ of the derma become hypertrophied, and appear as round or conical prominences close together, and covered by a smooth and shining epidermic layer. These increase in volume; and in the furrows between them appears a fœtid, sero-purulent matter, chiefly composed of serosity and a mass of epidermic cells. In this product, the Chorioptes of all ages—males and females—are found in considerable numbers, as well as their eggs, the débris of their moultings, and their excrements.

Etiology, Contagion.—Chorioptic scabies is never seen in well-bred Horses, because of the orderly way in which they are kept, and the fineness of the hair on their legs. It is the appanage of common Horses, which have coarse long hairs on their limbs, and in which the skin is habitually dirty. This is the reason why it is most frequently seen on young Horses which, not yet at work, are not regularly groomed; as well as on old worn-out animals which have fallen into careless hands, and which are near their final stage—the knacker's establishment.

Contagion is effected by grooming articles, but more especially by litter, in which the Chorioptes may live for a long time. Gerlach has kept them with crusts in a warm place, and at the end of ten to twelve days they appeared to be dead; but heat and moisture rendered them active in fourteen days. In the spring, or in a

place not warm, they have succumbed in fourteen days, and in fifteen in a stable. Delafond and Bourguignon have kept them alive from sixty to sixty-five days, in boxes placed in a stable, with a temperature of 14° to 15° Cent. (57·2° to 59° Fahr.), care being taken to renew the air in the box and to maintain a proper amount of humidity.

The disease owes its extension to transmission from diseased to healthy Horses. The Choriopt of the Ox conveyed to the Horse, disappears without attacking the skin; while that of the Horse transplanted to Man, and other creatures than the equine species, has produced no results.

Chorioptic scabies is the least contagious of the three forms of equine scabies, as the Choriopt has little tendency to emigrate, often remaining localized on one limb, or on two anterior or posterior limbs. Gérard and Railliet completely failed in their well-conducted attempts to develop the disease on Horses, by depositing the parasites in the hollow of the pasterns. It is true that they experimented with old Horses; and Railliet is inclined to believe that the disease is proper to young Horses, the cases recorded as occurring among old Horses being due to the persistence of the malady from their earlier years.

Diagnosis.—With regard to this, there is nothing to be added to what has been already said concerning *sarcoptic* and *psoroptic scabies*. The markedly special seat of chorioptic scabies, its symptoms, and the facility with which the parasites are always found, should prevent mistakes, and particularly if it be remembered that the simultaneousness of the two forms of scabies is possible.

Prognosis.—This disease—the most benignant of the manges of the Horse—only persists when the horse-owner allows it to do so; as it is most easily got rid of, and is only serious when complicated with cracks in the skin and papillary growths, which, after they have been cured, often leave thick cicatrices.

Treatment.—To prevent the somewhat inactive contagion of chorioptic scabies, it is well to isolate the affected Horse, or, at least, to often renew its litter and look well to grooming, for cleanliness is always one of the most efficacious of the curative agents.

The hair should be removed as close as possible from the invaded regions, and even a little beyond them; then the brush or wisp will remove, along with the crusts and scurf, quantities of parasites and ova. The whole of the affected parts are then to be well rubbed with soft soap, which should be allowed to remain on for about twenty minutes, when it is to be washed off with warm water, and the skin treated with the scraper and well dried.

The antipsoric medication properly prescribed by Delafond and Bourguignon, consists of friction either with a concentrated decoction of tobacco, the pomade of Helmerich, or—which is more expeditious—benzine or oil of turpentine. One, two, or at most three, rubbings with one or other of these agents suffices to completely cure the disease. At the Toulouse Veterinary School, a

mixture of equal parts of petroleum and linseed-oil is employed. A mixture of Stockholm tar or cade-oil with an equal part of soft soap, applied warm over the whole of the affected surface, gives excellent results when the disease is chronic ; but when it is accompanied by hypertrophy of the papillæ, then there should be applied, and more than once, the mixture of tar and soft soap, to which should be added 2 to 5 grammes of finely-powdered arsenious acid to 500 grammes of the mixture.

B.—Scabies of Bovine Animals.

It had been known for a long time that bovines might be affected with psora, as Delafond and Bourguignon state that it is mentioned in the writings of Columella, who lived in the first century of our era, and also in those of Vegetius. Since the establishment of veterinary schools, bovine scabies has been frequently observed, and its parasitic nature has been clearly recognised. It might appear at first sight that the Ox, like the Horse, should be affected with the three forms of scabies, of which the pathogenic agent is a Sarcopt, a Psoropt, and a Choriopt.

1. *Sarcoptic Scabies.*

Sarcoptic scabies of the Ox is only incidentally mentioned here, as its history is limited to the possibility of its existence. Grognier, indeed, mentions that the mangy Horse alluded to at p. 133 communicated its disease not only to several people, but also to two Cows placed alongside it in the stable. The transmission to Man demonstrated the sarcoptic nature of the affection. It was the same with the case recorded by Robert Fauvet : the mangy horse sold to a miller infected a Cow that had rubbed its neck against the manger.

Wallraff has reported the history of an epizoöty of mange that prevailed among Goats in the valley of Prattigau, Canton of Grisons. The disease was communicated to Man, and was therefore sarcoptic ; it was transmitted to cattle and Horses. Delafond produced a fugaceous form of mange that disappeared spontaneously, in depositing some Sarcoptes from a diseased Dog on the skin of a Bull and a Calf. McFadyean reported a case of sarcoptic mange of the Ox in 1900.

These are all the facts that are known of the sarcoptic scabies of the Ox. Rademacher relates that a mangy Cat, which was in the habit of resting on the back of a Cow, infected the latter ; the Cow gave the disease to a servant, and she, in her turn, gave it to all the family. It will be shown hereafter that the scabies of the Cat can be conveyed to Man ; but as it is due to the *Sarcoptes minor*, and not to *S. scabiei*, the instance given by Rademacher cannot be accepted as of equal value—so far as the history of bovine sarcoptic scabies is concerned—with that of equine scabies, due to the *S. scabiei*. For the same reason, the incomplete, and even inexact, observation of Thudichum, relative to the development of scabies in people who had been in contact with a mangy Cow, cannot be utilized.

2. *Psoroptic Scabies.*

Synonyms.—*Dermatocoptic scabies* Röll ; *Gale dermatodectique* Delafond.

History.—According to Sauvages, Linnæus observed on cattle a mange that was caused and maintained by insects, which were found located in the tubercles of the skin ; but, in reality, the first mention of a parasite—in 1813

—is due to Dorfeuille, a veterinary surgeon at Port-Sainte-Marie (Lot-et-Garonne, France), who reported his discovery to Gohier, who, in the following year, found this acarus on the Hungarian cattle which the Austrians brought in large numbers with their army to Lyons. Gohier did not remark any difference between this animalcule and that which he had seen—the *Psoroptes communis*—in a form of mange of the Horse. After long search, Delafond in *1856* discovered this parasite on English and Limousin cattle, at the same time that Gerlach found it on mangy cattle at Bromberg. This form of scabies was again seen by Müller in 1860, and since that time it has been observed at intervals on French cattle. The disease is not uncommon in the United Kingdom (Fleming).

Symptoms.—The psoroptic scabies of the Ox has great analogies with the same form in the Horse. It commences at the root of the tail or—though less frequently—at the neck or withers, and gradually extends to the head, back, shoulders, sides of the chest, and finally invades the entire surface of the body, except the limbs.

There is violent pruritus: the animal scratches and rubs itself in every possible way, and often causes blood to flow from the affected parts. An attentive examination discovers—at the place where the disease commences—small, miliary, epidermic elevations, discrete or confluent, filled with serosity. This escapes, agglutinates the hairs, dries, and gives rise to very adherent crusts, which increase in number and extent. There are soon seen on the skin numerous patches of mange—depilated, borders irregularly festooned, covered with thick, greyish, scaly or lamellar crusts. Beneath and between these crusts the Psorptes multiply. They can be readily seen by the naked eye, or by means of a lens, in spreading skin-scrapings on black paper in a warm place. The skin itself, when freed from crusts, is seen to be depilated, thickened, hard, dry, and cracked, with thick folds on the sides of the neck, shoulders, and chest.

In serious and neglected cases ulceration may ensue, due more especially to the continual rubbing. The animals then fall into a state of extreme cachexia; the superficial lymphatic glands in the adjacent regions are hard and prominent, but not painful; and death is the sequel to this miserable condition.

Gerlach and Müller have remarked on the modifications occurring in this form of scabies by change of season. On a farm in the circle of Inowraclaw, the disease prevailed among the cattle every year, commencing towards the end of autumn when the animals began to be housed, reaching its maximum in February, and diminishing in spring, when the oxen were employed at labour; the crusts then became detached, the hairs grew, and there only remained a few bare patches at the root of the tail and on the neck, while around the horns and on the neck epidermic scales were abundant. The train of symptoms reappeared each autumn. Gerlach and Müller recognised that the Psoroptes persisted in summer, although the Oxen appeared to be cured; the parasites were in great numbers on the neck and around the horns, and Chorioptes were mixed with them.

It would appear from these facts, that the residence of the Oxen

in warm stables during the winter favours the development of the parasites.

Etiology, Contagion.—The immediate cause of this scabies is the *Psoroptes communis*, var. *bovis*. Conveyed to healthy animals, it develops the same disease on them. It may, nevertheless, be admitted that poverty and uncleanliness are predisposing causes; and it has been shown that dwelling in a stable during winter favours the development of this malady, while living in the open air during the summer does not.

May the Ox contract psoroptic scabies from other domesticated animals with which it comes in contact? Gohier and Carrère have reported affirmative facts, in which Cows have acquired the disease after being—for a variable period—beside a mangy horse. But they have not given details as to the characters of this psora, either on the Horse or the Cow; so that it is impossible to give an opinion as to whether it was this, or one of the other forms of scabies. The experiments with regard to the transmission of psoroptic scabies from the Horse to the Ox, made by Gerlach, and more especially by Delafond, carried out under the most satisfactory conditions, have always yielded negative results—Delafond only once having observed a fugitive pruritus that was not followed by scabies. And it is also the fact, as demonstrated by the experiments of Delafond, that the Psoropt of the Sheep cannot be acclimatized on the Ox. Only on two occasions in five did the transplanted parasites attack the skin of the calves experimented upon—thin crusts were formed, but the Psoroptes died or disappeared in from three to six days. Inversely, attempts at transmission of the psoroptic scabies of the Ox to the Horse were without result in the hands of Gohier and of Müller.

Diagnosis.—The psoroptic scabies of the Ox might, in one of its phases, be mistaken for certain cutaneous affections which somewhat resemble it. But the error may be averted by a careful examination, which will decide whether or not the Psoroptes—so easily found and distinguished from every other parasite—are present.

The *Phthiriasis* due to the *Hæmatopinus eurysternus* and *H. vituli*—which are very pruriginous, cause depilations, and locate themselves on the upper part of the neck and withers—is easily recognised by the presence of the Lice; but as it may coincide with scabies, something more than a superficial examination is necessary. However, the treatment usually employed against lice will destroy the parasites of Mange.

The *prurigo* that results from heating food, or the sudden transition from a poor *régime* to an abundant ration—and sometimes appears without any appreciable cause—may extend to various parts of the body or be limited to some. It is characterized by discrete papules—which may be small and soft, or voluminous and hard—that cause a violent pruritus, particularly when the body is heated. In consequence of rubbing, the excoriated papules are

covered with blood-tinted crusts, and the skin is thickened, chafed, moist, and depilated in patches. This disease may quickly subside spontaneously, but it may also continue for months. It has a great resemblance to scabies, and especially when it manifests itself on several animals at the same time in one place; then contagion might be suspected. The diagnosis will be decided by the absence of acari, and by the utility of internal treatment—alteratives, purgative salines, arsenious acid, etc.

In *ringworm*—which is contagious, like scabies—the patches invaded by the *Trichophyton* are always circular, and have limited dimensions—from 3 cm. to 5 cm. in diameter; while those of scabies are irregular, and have a disposition to extend along the body. Besides, each of these two affections has its own proper parasite, the presence of which fixes the diagnosis.

Prognosis.—Psoroptic scabies in the Ox can only become serious when it has been absolutely neglected, and the cachexia accompanying it has become chronic; for it readily yields to various antipsoric remedies.

Pathological Anatomy.—G. P. Piana has given the following *résumé* of his researches into the lesions of the psoroptic scabies of the Ox.

The Psoroptes induce very limited exudative inflammation in the regions of the derma corresponding to the points where they have inserted their mandibles in the epidermis; the exudate resulting from each of these inflammations is infiltrated between the cells of the rete mucosum, and also collects in the substance of the epidermis itself. This exudation is very rich in leucocytes, which, owing to their movements, become insinuated—along with the fluid portion—between the deeper epidermic cells.

Consecutive to these changes, and according to the intensity of the dermal inflammation, the alterations may assume two different aspects. In the first, the formation of the exudate ceases, and new epidermic layers are established beneath the already developed exudative masses, which fall off afterwards with the epidermic scales. In the other case, the exudation continues, and the product already accumulated in the substance of the epidermis continues, until it causes rupture of the horny layer, and complete destruction of the rete mucosum—hence more marked irritation and the possible formation of a veritable ulcer.

When the punctures of the Psoroptes are confluent, instead of small and distinct inflammatory points, a very extensive exudate is thrown out, which, in drying, forms a crust.

Treatment.—The curative measures indicated for the psoroptic scabies of the Horse are in every way applicable to the same form in the Ox. Mercurial preparations should *on no* account be employed, as they may be absorbed and cause more or less serious poisoning; for cattle are particularly liable to hydrargyrism, and numerous instances are recorded to prove the danger incurred from the use of these preparations. These dangers are due, for the most

part, to the great tendency of the larger ruminants to lick themselves, and especially whenever they experience any itching sensation. In addition to the mercurial preparations, all toxic substances—such as cantharides, arsenic, etc.—likely to create another disease than that to be combated, should be absolutely proscribed.

3. *Chorioptic Scabies.*

Synonyms, History.—*Dermatophagic scabies* Röll, *Chorioptic scabies* Mégnin. This form of scabies is very rare in France, but it has been particlularly studied in Germany. According to Gerlach, the first mention of the acarus which produces it is due to Kegelaar in 1835. But it was Hering, of Stuttgart, who was the first to make known in a positive manner, in 1845, this form of psora, and who described, distinguished, and exactly figured the Choriopt that lives on the Ox. This study was undertaken and happily developed by Gerlach in his treatise on scabies. Delafond and Mégnin have also, though rarely, met with the Choriopt of the Ox.

Symptoms.—This form of scabies has its seat almost exculsively at the base of the tail. The pruritus is moderate. An abundance of scurf covers the affected part; the hair gradually falls off; then crusts and cracks form, which are inhabited by numerous acari. It is only when cleanliness of the skin is altogether neglected, that the disease goes beyond the root of the tail, and extends to the back and neck in one direction, and to the perinæum, mammæ, and inner surface of the thighs in the other direction. In general, it remains localized for years at the base of the tail and in the anal fossa. In some cases observed by Müller, during the summer the parasite was located along with Psoroptes at the nape of the neck.

It is not a serious malady that injures the health of the affected animals to any sensible extent, unless, by negligence—prolonged for months, or even years—it is allowed to spread to other parts of the body. Then, owing to the general disturbance in the cutaneous functions, it may bring on anæmia and the unthriftiness observed among such animals.

According to Johne, bovine animals often have the Chorioptes on their posterior pasterns without manifesting the slightest pruritus.

Etiology, Contagion.—Chorioptic scabies of the Ox is little contagious. Diseased cattle have been known to cohabit with healthy ones for four years without transmitting the disease. It is not contagious for Man, nor for the other domesticated animals. Deposited on the human skin, the Choriopt of the Ox may produce a few red points and a slight itching, but these phenomena do not persist beyond twelve to sixteen hours. Scurf applied in the pasterns of the Horse causes papules and pruritus that disappear in a few days.

Inversely, Delafond and Bourguignon have, on two occasions, deposited a large number of Chorioptes of the Horse—males and females of all ages — on the tail and around the anus of four emaciated and weakly Cows; the parasites attacked the epidermis

caused scurf, and produced the disease; but in fifteen days afterwards they had all disappeared, and the scabies was cured spontaneously in twenty days.

Diagnosis.—The Chorioptic and the *psoroptic scabies* are difficult to distinguish from each other at their commencement. To arrive at a sure diagnosis, prepared by the differential characters of the lesions, it is indispensable to discover the parasite by means of the microscope.

A superficial examination might lead to the supposition that Chorioptic scabies was the *phthiriasis* due to the *Trichodectes scalaris*, when this has its seat on the posterior parts of the body and root of the tail; as it is accompanied by a furfuraceous eruption, depilation, and slight pruritus. The distinction between the two diseases is very easy, inasmuch as the dimensions of the Trichodect are at least four times greater than those of the Choriopt, and their specific characters are widely different.

The ringworm of the calf can scarcely be mistaken for this scabies, as that dermatomycosis has always a more or less regularly circular form.

In the same way, *prurigo* is distinguished by the character indicated above, *à propos* of the psoroptic scabies of the Ox.

Treatment.—The treatment of this form of scabies does not require any special recommendation. To cure it, the same procedure as for psoroptic scabies of the Ox will suffice.

C.—Scabies of the Sheep.

The Sheep, like the Horse and Ox, may present three forms of scabies—sarcoptic, psoroptic, and chorioptic. Living in flocks—which is the rule with ovine animals—gives to their acariases a particularly serious character, as it considerably facilitates contagion. And this is also increased by the long time the litter is allowed to lie in the sheepfolds, only a small number of parasites being at wide intervals carried to the manure-pit. Besides, the development of the wool furnishes an efficacious shelter to the Acarina, and offers great opposition to the action of antipsoric agents—difficulties which are augmented by the fact of the large number of animals that the shepherd has to look after, and consequently gives rise to irregularity in the effects of treatment. All these causes explain the tendency of scabies to be perpetuated in flocks which these diseases have invaded. And what adds still further to their gravity, is the circumstance that not only do they injure the health of the animals, but they also at times greatly depreciate the value of the wool.

These various reasons account for the large amount of attention that the scabies of the Sheep has received, and the careful studies of which they have been the object, and principally with regard to treatment.

They will also justify the somewhat detailed allusion we will make to them in the following pages.

1. *Sarcoptic Scabies.*

This form of scabies has been for a long time designated (in France) *Gale de la tête, Dartre de la tête, Teigne, Vidragne, Lézard*, and more especially *Noir-museau*—a name also given to an ulcerous affection of lambs, attacking the lips and around them. Jehan de Brie, in the fourteenth century, named it *Poacre*. 'Et est le poacre une maladie et manière de rongne, qui prent et tient ès museaux des brebis.' But until the time of Delafond no one knew that this disease was a real psora, caused by the *Sarcoptes scabiei*, var. *ovis*. It was in 1858 that he observed it in Neapolitan Sheep brought to Paris; and it has since been described by Gerlach. We have observed it in the neighbourhood of Toulouse, where the shepherds call it *Musarail*. In Beauce its ordinary name is *Becquériau*.

Symptoms.—This scabies has its seat almost exclusively on the head. It appears first on the upper lip and around the nostrils, much more rarely on the eyelids and ears. Later it extends to the face, forehead, cheeks and eyelids, and exceptionally to the intermaxillary space. According to Chabert, 'it is only when the disease is of long standing that it shows itself between the forelegs, beneath the belly, around the joints, and especially behind the knees, the hocks, and the pasterns. In this way it differs,' he adds, 'from ordinary scabies, for it appears to avoid the parts covered with wool.' Gerlach, in fact, could not succeed in developing it on the woolly parts of Merino Sheep; and this was probably due to the abundance of yolk in these regions, for with dry-wooled Sheep—Zackel Sheep, Fat-tailed Sheep, and the Neapolitan Sheep—the malady may gradually extend all over the body.

It commences by an eruption of small vesicular papules, accompanied by violent pruritus, which compels the animal to rub itself against everything about it, and less frequently to scratch itself with its hind-feet. The papules, being chafed by this friction, exude a serosity that, in drying, forms small, hard nodosities adhering to the skin, which the finger-nail discovers among the hair. Cracks may be seen on the ears when the disease begins there. The multiplication of the parasites and their extension, generalize the disease over large surfaces. The anterior surface of the head is covered with crusts, at first thin, but becoming afterwards thick, light-coloured or greyish, hard and adherent. At a more advanced stage, all the diseased places merge into one, and the lips, nostrils, face, cheeks, forehead and ears are a vast crusted surface—dry, thick, and made even by repeated rubbings.

The skin is thickened and raised in folds, at the bottom of which are fissures and cracks that bleed at first and then cicatrize. Delafond says the ears may have sero-sanguinolent cysts, due to the irritation induced by the friction.

The animals may have some difficulty in taking their food; and the conjunctivæ may be injected and the eyes muco-purulent.

The acari are found beneath the adherent layer of the crusts, which is moist when removed by forceps.

The duration of this scabies is subordinate to the care taken in

its treatment. If not perseveringly attended to it may be indefinitely perpetuated.

Etiology, Contagion.—The older (French) authors and shepherds believed the *noir museau* to be due to wounds and scratches, produced on the nose and around the lips of the Sheep, when these animals were grazing among stubble, briars, thorns and stones, or in rubbing these parts against the bars of the rack when taking forage. The lambs are seldom affected, the *noir museau* seen on them being quite different, and of an ulcerative nature. The true cause of the disease is contagion, and this is why it is perpetuated in sheepfolds, by immediate and mediate contact; and especially by the fact of the racks against which the Sheep rub themselves—either in taking their food or to allay the itching—being soiled by crusts charged with the Sarcoptes.

Can the sarcoptic scabies of the Sheep be derived from the sarcoptic scabies of any other domesticated species? Viborg admits that the scabies of the Pig may be transmitted to the Sheep, though Am-Pach is of the contrary opinion; but there are no facts in support of either view, and the same may be said with regard to Chabert's assertion, that the scabies of the Dog may be conveyed to Sheep. Only for the sarcoptic scabies of the Goat has transmission to Sheep been demonstrated, as Wallraff and Roloff have shown; the communicated disease bore the closest resemblance to the psora just described.

The sarcoptic scabies of the Sheep may be conveyed to Man. Delafond has seen a breeder contract the disease through attending Sheep affected with it; while Gerlach succeeded on several occasions in effecting transmission to a student, and each time treatment had to be resorted to for the arrest of this experimental malady. Nevertheless, the contagion of Man should be extremely rare, as no other instance has been observed in practice.

Gerlach has stated that if sarcoptic crusts from the Sheep are placed on the skin of the Horse, Ox, or Dog, there is developed at the places a local scabies that has not extended at the end of four weeks. With the Goat—contrary to what had been observed by Roloff and Railliet—at the expiry of three weeks it was still doubtful if transmission had occurred, as there was not a trace of scabies.

Diagnosis, Prognosis.—The sarcoptic scabies of the Sheep cannot be mistaken for any other disease. Its seat distinguishes it from psoroptic scabies, and the presence of the special parasite found in the moist portion of the crusts is sufficient to remove any doubts.

It is not a serious disease, and readily yields to treatment. But if left to itself it may cause conjunctivitis and painful otitis; while it may prevent fattening by the pruritus it occasions, and the changes it may induce in the skin of the lips. Its gravity consists more especially in the difficulty experienced in purifying the sheepfolds, without an operation that seems out of proportion to the object to be attained.

Treatment.—The prophylactic measures for preventing the in-

vasion of the disease—the contagion—are those mentioned with reference to psoroptic scabies.

With regard to curative treatment, this always yields good results if the application is rational; the rapidity of cure is subordinate to the age of the disease. If at its commencement, antipsoric remedies may be applied at once; but if it is of long standing, and the skin is covered with thick crusts, then these should be softened by repeatedly rubbing them with some greasy matter for several days, when they may be removed by soap washing and picking.

Then, over the entire diseased surface and the adjacent parts, there should be well rubbed in the oil of turpentine, or—what is better, being less irritating—the essence of spike lavender. According to Gasparin, a cure may be obtained by a single application of cade-oil over the affected surface. Two or three rubbings with a mixture of equal quantities of pine tar and soft soap, or with the pomade of Helmerich, will also promptly cure this scabies (Delafond).

The same treatment is applicable to exceptional cases, in which the scabies has extended to between the fore-limbs, belly, mammæ, knees, hocks, and pasterns.

The local complications—cracks, fissures, cysts, conjunctivitis—are to be treated according to the general principles of therapeutics applicable to them.

2. *Psoroptic Scabies.*

Synonyms, History.—The *Rogne*, *Tac*, and *Gale épizoötique* of the older (French) writers; the *Dermatodectic scabies* of Gerlach, Delafond and Bourguignon (the *Scab*, *Shab*, *Ray*, *Rubbers* of the English shepherd; the ſceb or teter—*Sceb*, *Sceal*, or *Teller*—in the early Anglo-Saxon manuscripts; the *Räude*, *Krätze*, *Schabe*, and *Grind* of the Germans; the *Rogna* and *Scabbia* of the Italians; the *Sarna* of the Spanish; the *Tschesotka* of the Russians; the *Rüh* of the Hungarians; the *Skab* of the Danes; and the *Scabb* of the Swedish). Delafond and Bourguignon, in their *Traité pratique de la Psore*, have given extensive details in the history of our knowledge relative to this malady. From this it is seen that the first mention of it extends as far back as Cato the censor, about 160 B.C. Then it is spoken of in Virgil's *Georgics* and Juvenal's *Satires*, and in the works of Celsus, Columella, Pliny, and Vegetius. In the Middle Ages, Belon mentions it, and indicates its treatment with cade-oil, which he called *tac*.

In England, 'sheep-scab' has been known from the earliest times, and it is frequently mentioned in ancient Anglo-Saxon manuscripts; it is also alluded to by Chaucer and other writers of a later period; while evidence of its destructiveness is found in the record of such an epizoöty as that described by Thomas of Walsingham and Stow, which persisted among the Sheep throughout this country for more than twenty-eight years.

Laws were made in Britain with regard to it as early as the reign of Howel the Good of Wales—when it was known as *ar clauri* or *clauery*—at the commencement of the eleventh century; and at a later period it frequently received legislative notice (Fleming).

Although in the twelfth century Avenzoar had made known the existence of the Sarcopt of human scabies, it took a very long time for this knowledge to be extended to the important psora of the ovine species. It is doubtful if Linnæus in 1735, Ettmüller in 1754, Morgagni in 1760, or Werlhof in 1765, ventured on the hypothesis as to the existence of a parasite in Sheep scabies.

Many subsequent writers on the disease are absolutely silent on this special point. It has been shown (at p. 107) that Wichmann, in 1786, was the first to think that scabies of Sheep was of the same nature as that of Man, and that both diseases are produced by *the same acarus.* He even goes so far as to say, that if the persons who handle wool are often affected with itch, the cause must be sought for in *the transmission of the acarus of the Sheep.* Abilgaard, director of the Copenhagen Veterinary School, accepted this idea, for he said, in 1787, that 'the Sheep itch was cured by simple external remedies, without having recourse to internal ones.'

But Walz, a veterinary surgeon of Wurtemberg, should be placed in the front rank of those who have made known the causes, nature, seat, and rational treatment of Sheep psora. In his memoir, published in 1809, and translated into French in 1811, he had, by varied experiments, given a positive basis to ulterior researches. From that time, the notions of the parasitic nature of scabies and its contagiousness, are seen to be more clearly understood in the writings of Tessier in 1810, of Bosc in 1811, of Gohier in 1814, of Gasparin in 1821, etc.

Lastly, the precise researches on the entomology of the Psoroptes of the Sheep, and the nosography of the scabies it causes, have been pursued with science and method by Hering (1835), Hertwig (1835), Delafond and Bourguignon (1854), and Gerlach (1857).

Symptoms.—Attention is at first attracted by slight alterations in the fleece, which is fluffy and matted in places. If the suspected Sheep is carefully watched, it will be observed rubbing, scratching, or gnawing itself, and tearing out the wool. These phenomena become all the more apparent when the flock is heated by travelling. Rubbing with the hand on the parts where the wool is matted or thin, still further excites the sensations of pruritus; the animals move their lips in a tremulous manner, shake the head, seek to bite the skin with their teeth, and scratch it with their feet. When the latter are dirty they soil the fleece at the itching part.

On examining the skin, papules will be found the size of a lentil or larger, of a whitish or yellow colour, which contrasts with the faint rosy tint of the integument—this is the result of the puncture of the Psoropt. The punctures becoming more numerous, the papules are closer together and become confluent, while the skin is thickened to a generally limited extent. At the summit of the papules serum accumulates, which transforms them into vesicles and pustules, and in drying forms crusts. In a few days the mangy surfaces are covered with a yellowish, scaly layer, greasy to the touch, beneath which the parasites are concealed. The repeated and multiplied action of the Psoroptes extends the inflammation of the derma, increases the exudation, and gradually changes what were at first scales, into crusts of average thickness. These are loosened, particularly by the continual rubbing, tearing the fibres of wool from their follicles; so that the depilation increases. The crusts fall off, and are replaced by others, which are thicker, and more compact and adherent. The psoric patches extend at their periphery, as the acari forsake the centre, the crusts of which are replaced by an abundant desquamation of the epidermis; but little by little this part recovers its integrity, while the morbid process is continued beyond, though for a long time it remains thickened

and wrinkled. With animals which are clipped, there usually forms at the diseased points a thick, dry crust, like parchment, that covers the greatly tumefied skin.

The fleece of the mangy Sheep has a quite characteristic neglected appearance—the wool being agglutinated in certain parts, absent in others, and is easily pulled out in the regions which appear to be yet intact. The rubbings in which the Sheep indulge accelerate the depilation and augment the irritation of the skin, which becomes inflamed from contusion, and even by superficial necrosis.

Contrary to what happens with the Sarcopt, the Psoropt seeks the regions covered with wool. Therefore the ordinary mange usually begins at the upper and middle part of the body—the withers and back—and thence extends to the neck, flanks, and croup. The Psoroptes are rarely found in the sternal and sub-abdominal regions; they agglomerate on circumscribed surfaces, and the scabies they produce is manifested in the form of patches always increasing at their periphery; the number of these patches is that of the points of invasion. But as incessant contact facilitates the mutual passage of the Psoroptes from one individual to another, the process becomes more confused, as the patches become multiplied and are of various dimensions, until at last they become confluent.

The parasites abandon the regions where their presence has caused the formation of dry compact crusts, or where the derma is thickened and indurated; so that very few can be found there. On the contrary, however, they are found in abundance at the parts more recently attacked—the margin of the mangy places, where they are visible to the naked eye as small white points, brownish at one extremity, and may be lifted up by means of a pin or small brush. If they are then put on a sheet of black paper in a mild temperature, they can be seen moving about, and the males may even be distinguished from the females—especially by means of a hand lens—and pairs seen in copulation, are relatively very numerous.

The Psorptes multiply abundantly on lambs and tegs, the skin of which, being tender and delicate, offers them a more favourable *habitat*. They prefer parts where the wool is close, and after the Sheep are shorn they emigrate in a body to others which have not yet undergone that operation.

Course, Duration, Termination.—The seasons and the conditions in which the animals live exercise an influence on the course of scabies. In autumn and winter (in France), when they are collected in the hot and damp atmosphere of the sheepfolds, and covered by their fleece, the disease makes rapid progress. In summer, when at pasture, and after shearing and washing, it is often checked, and sometimes even suspended.

The age and temperament of animals, the length, fineness, and abundance of their fleece, their condition and energy, their breed, and the hygienic conditions to which they are subjected,

all have much influence on the course and terminations of this malady.

Animals debilitated from any cause offer little resistance to it. Those of the pure or mixed merino breed, sooner give way to it than the indigenous breeds.

Left to its natural course, this scabies has a fatal result, because of the cutaneous disturbance, the fatigue, and want of rest and sleep from the pruritus. Marasmus and cachexia precede death, which, in emaciated and debilitated subjects, may take place in two or three months. An abundant and substantial nourishment prolongs life; but if even then an incomplete external treatment is applied now and again, the disease may last for years, and remain stationary in a country or on a farm.

Etiology, Contagion.—All the experiments made, as well as all the observations from the earliest times, have demonstrated the predominant part played by contagion in the etiology of Sheep scabies. The intimate contact of animals in the sheepfolds renders this contagion very easy, and it often suffices for one mangy Sheep to be introduced into a flock to infect the whole. The experiments of Delafond have demonstrated—what to-day appears superfluous—that, as Walz and Hering had already stated, the morbid humours of Sheep scabies contained neither Psoroptes nor their eggs, and therefore could not transmit the psora; and that contagion could only occur by means of the eggs or the fecundated females.

Transmission of the scabies is produced by the mediate or immediate contact of the diseased with healthy animals in the sheepfolds, parks or pastures, and by the collection of flocks at fairs, markets, and watering-places. It also occurs when healthy Sheep come in immediate contact with objects on which the mangy ones have rubbed themselves a short time previously, and on which they have left crusts and shreds of wool with their parasites.

From the experiments of Hertwig and Gerlach, and particularly of Delafond, it results: 1. That the Psoroptes of the Sheep infesting crusts, portions of wool, or pieces of fresh skin, kept at a medium temperature, can live in these for ten to twenty days; 2. That they will remain torpid in these matters if they are subjected to a slight degree of cold, but become re-animated by a mild damp heat; 3. That they die quickly when remaining in contact with animal matters kept at a temperature of zero; 4. That they soon perish if exposed either to a high or a low temperature.

These diverse experiments demonstrate that the Psoroptes may persist in living in sheepfolds, though exiled from the bodies of animals for at least twelve to fifteen days; and they also demonstrate the necessity there is for removing from these places all litter, remains of wool, and the skins of Sheep which have died or been killed, as well as disinfecting the localities inhabited by mangy sheep.

The experiments and observations of Delafond have placed beyond doubt, the influence of the health of animals on their power

of resistance. Good condition, energy, and a succulent and abundant alimentation, are all antagonistic to the multiplication and existence of the acari; while emaciation and poverty of the secretions are favourable to the nutrition of these animalcules, the incubation of their ova, the alimentation of the larvæ, and multiplication of the colonies, and, consequently, contribute to the extension, persistence, and aggravation of the disease. With robust and well-fed animals, mange will disappear spontaneously, or be readily cured by cleanliness and some antipsoric remedies; while with poor, weakly, and chlorotic Sheep it will persist and become tenacious, and most difficult to cure if the organism is not restored by good food, by attention to cleanliness, and by an energetic parasiticide medication.

It has been stated that, although of the same species as that of the Sheep, the Psoropt of the Horse does not become acclimatized on ovine animals, according to the experiments of Delafond. If similar attempts have not been made with the Psoropt of the Ox or that of the Rabbit, yet it may be provisionally admitted that it is always from Sheep to Sheep that psoroptic scabies is conveyed.

With regard to the possibility of transmission of this scabies to other species of animals, as already mentioned, Delafond obtained negative results on the Horse and Ox; and he also failed with the Goat. The influence of seasons on the extension of Sheep scabies has also been indicated; the effects of cold and damp are also shown by the geographical distribution of the disease—for it is more frequent in Germany than France, and in the latter country it is more common in the north and west than in the east, and particularly in the south.

Diagnosis.—Psoroptic scabies cannot be mistaken for *sarcoptic scabies*: their localization is altogether different, and they never interfere with each other; the first only affects parts destitute of wool, the second only the woolly parts of the body; and when they chance to co-exist on the same animal, they are easily recognised by their distinctive characters.

Confusion is more likely to occur with *inflammation of the sebaceous glands*, described by Delafond, which appears most frequently in the autumn, when the Sheep have suffered from lying on the cold ground, and have lost condition. It is marked by somewhat severe pruritus, followed by the shedding of tufts of wool; the skin is also red, sensitive, painful, and—an important feature—it is covered with a large quantity of yellow, rancid, and viscid yolk, which smells very strongly. This latter symptom, the absence of the Psoroptes, and the facility of cure by the employment—after shearing—of any amylaceous lotion on the diseased parts, serves as a differential diagnostic indication.

The pruritus due to the *Melophagus*, the *Trichodectes*, and the *Ixodinæ*, is readily attributable to its cause by the discovery of these large and distinctive parasites.

The Germans designate by the name of 'Rain-rot' (*Regenfaule*)

an eczema due to humidity, which may manifest itself on the whole flock. Its rapid cure on the advent of dry weather or residence in the sheepfold, the benignity of the cutaneous alterations, and the absence of pruritus, render diagnosis easy.

It may also happen that an exaggerated secretion of the yolk agglutinates the locks of wool, and might for a moment lead to the suspicion of scabies ; but the absence of pruritus, and the complete integrity of the skin, will dispel this error.

Prognosis.—Psoroptic scabies of the Sheep is not serious, if only the dangers individual animals incur from it are considered. It is always easy, in fact, to cure a mangy Sheep by isolation, an abundance of substantial food, and good antipsoric treatment. But what gives the disease a character of exceptional gravity, is the circumstance that Sheep always live in flocks, so that the malady is quickly propagated by this mode of existence and the close promiscuity that it entails ; and also that the fleece constitutes a special difficulty in the application and action of medicaments ; while it is necessary to treat the whole flock at the same time, and under expensive and troublesome conditions.

Besides, when the animals are, by their feeble temperament, in conditions favourable to the development of scabies, the mortality by cachexia or other intercurrent affection exacts its tribute from the revenues of the flock. It is often disastrous in the autumn, and during the winter and spring, by the seasonable recrudescence of the disease. 'The annual losses, under ordinary circumstances, may rise to 10 and 20 per cent. ; in the case of inveterate scabies the mortality may increase to 40 and 50 per cent. ; and in instances in which the disease is complicated by any other serious affection, and especially by dropsy, it may reach 70 to 80 per cent.' (Delafond).

In addition, the torment experienced by the animals hinders their growth and fattening ; a large number of ewes remain unfruitful, abort, or only produce small and feeble lambs, the majority of which die. Lastly, the wool undergoes a notable depreciation, which will be alluded to presently.

In 1862, Delafond, after what he considered moderate calculations, estimated that the psora every year attacked one thirty-fifth portion—or about one million—of the Sheep in France, and that through the mortality or otherwise the damage was five francs per head, or an annual loss of five million francs to French agriculture. If at the present day the number of Sheep has diminished, yet their value has increased in proportion. Otherwise, the improved methods of breeding and rearing Sheep, the greater care bestowed on them, and the application—though incomplete—of sanitary police measures, have much reduced the prevalence of Sheep scabies. In fact, according to the official report on the epizoötics (of France) in 1887, this disease had only attacked 10,591 Sheep, of which 10 per cent. died. It is, nevertheless, a serious affection, against which all the accumulated resources of experience should be brought to bear.

The loss occasioned by this form of Sheep scabies appears to be very heavy in Bavaria and some other parts of Germany; for Haubner has estimated it as high as two thalers—six shillings per head. Zundel reports a loss of 5,000 francs in a flock of 200 sheep in three years. Jacoby calculated the annual loss in wool from this disease, in the Erfurt district of Prussia, at 30,000 thalers; and Fürstenberg estimated that, in the Griefswalder district, where the malady had not long been known, the loss every year was from 35,000 to 40,000 thalers.

In 1859, according to Straub, the number of Sheep affected in the Wurtemberg districts was 683,842—497 flocks being infected in that and the two succeeding years. Reckoning the loss at three or four thalers per head, it will be seen that a very large sum of money was lost during that period. The deaths from marasmus and other complications were very numerous in 1862.

Pathological Anatomy.—On a portion of the skin where the disease is recent, the epidermis is raised by purulent serosity; and on a surface of 2 cm. to 3 cm. in diameter, there is a sero-sanguinolent infiltration, and, later, induration. The extent of these lesions may be from 4 cm. to 5 cm. When the disease is very advanced, the skin, which has been for a long time depilated is often double or treble its normal thickness, and is hard, ridged, and cracked in certain places, while its papillæ are hypertrophied. The subcutaneous connective tissue is infiltrated by serum, which is already organized in the deeper parts of the derma. The lymphatic glands adjacent to these greatly altered surfaces are enlarged, infiltrated, and rich in lymph. The lesions of the skin may extend to the formation in its substance of little purulent foci, which are, red in colour, and vary in size from that of a hemp-seed to a pea; while others, as large as a nut, are situated in the skin and subcutaneous connective tissue. The nearest glands are then inflamed, enlarged, and very salient beneath the skin; and, lastly, there may be found in the different digestive and respiratory organs the lesions of concomitant cachectic affections.

The alterations in the wool are serious, from an economical point of view. It is matted, soiled, and yellow, mixed with foreign matters, diminished in quantity from the shedding of numerous locks, and has lost much of its value. The fibres are unequal, and this is particularly noticeable in the following conditions described by Delafond:

'With many animals, and after the depilation, beneath the portions of the fleece remaining adherent on the surface of the diseased skin is developed a new secretion of wool, and soon these fibres become mixed in the detached ones and form a mass composed of old and new wool. This alteration, which the farmers, shepherds, and wool-dealers call *wool with two ends*—because each lock is composed of two layers of unequal length—may be observed not only in the wool covering the mangy surfaces, but also on the

healthy parts when the Sheep have suffered for a long time from repeated attacks of the parasites.

'This alteration is recognised when, holding the locks between the eye and the light, there is a clear zone at the part where the new fibres become interwoven with the old ones; and when, in pulling the lock by both ends, the two growths become disunited and constitute two separate locks. If, otherwise, the fibres are examined microscopically, it will be found that the older the growth is than the new, the diameter of each fibre is alternately constricted and enlarged, a condition that gives an inequality of resistance to the wool, and diminishes its value.

'Such an alteration in the wool is very detrimental to its employment in manufacture, as it is shorter, and the thread made from it is disunited or breaks when spun, while the material which it makes has no lustre, and is dry and of poor quality. It is also probable that wool so damaged, and impregnated with a yolk that has also undergone changes, cannot dye so well as that from Sheep in good health. We have some authority for expressing this opinion, after the experiments made by Roard, director of the dyeing department of the Gobelins manufactory in 1803, on wools from diseased and healthy Sheep.'

Treatment.—The treatment of Sheep scabies consists in the employment of antipsoric remedies. But it is, above all, necessary to protect the flocks from contagion. As this is very subtle, we ought not to lose sight of the information given by Delafond with regard to the influence of previous health on the development of mange. Animals should, therefore, be placed in the best hygienic conditions, and kept as much as possible from humidity; while the sheepfolds ought to be maintained in a proper manner, so far as ventilation and light are concerned. The qualities of the shepherd are of the first importance in this respect—the vigilance, zeal, intelligence, and practical knowledge of this helper will detect the disease at its commencement, and hinder its extension.

Alimentation occupies the chief place among the reliable prophylactic measures. Reuss, Hering, Daubenton, and Lullin—cited by Delafond—have published facts that demonstrate the happy influence of an abundant and substantial nourishment on the resistance of Sheep to scabies, and the readiness with which they can be cured. According to Gerlach, adult animals resist the malady all the better if they are well fed, and so may have it among them for years. 'The Spanish shepherds,' says Delafond, 'know very well that the flocks which contract the disease during the winter in the warm provinces of Estramadura, are easily cured by the most simple remedies in the succulent pastures on the mountains of the Sierra Morena, of Old Castile, of Navarre, and of the Asturias. The shepherds who have charge of the wandering flocks which, from the southern provinces of France, are driven to the pastures on the mountains of Cevennes, Dauphiny, and the Alps, every year make similar observations. In Switzerland these facts are common, and

are well known to all the farmers and sheep-dealers.' Delafond strongly and justly insists on the importance of the *régime* and good health of the Sheep, in getting rid of the disease.

To cure scabies necessitates the employment of antipsoric remedies. The treatment is complicated when a large number of animals have to be dealt with at the same time. At the commencement, when one, two or three Sheep are only slightly attacked, the shepherd—if he is careful—may arrest and destroy the disease by simple means: such as tobacco juice, oil of turpentine, cade-oil, etc. But when the malady is installed in the flock, and all the Sheep are suspected of being more or less affected—so that it is impossible to determine the diseased places with certainty—recourse must be had to medicated baths, into which the animals are plunged one after the other.

Many substances have been for a long time tried and recommended for the treatment of Sheep scabies. Sea-salt and the various fatty bodies are abandoned as insufficient. Mercurial ointment, employed alone or mixed with other agents, ought not to be used, because of the danger of poisoning: for the facts reported by Gasparin, Jauze, Tessier, Numan, etc., as cited by Delafond, demonstrate the possibility of grave, even fatal, accidents following the absorption of this remedy either by the skin, or by the digestive mucous membrane when the mangy animal licks itself, when the Sheep lick each other, or when the lambs lick the ewes.. Empyreumatic oil and cade-oil are very active; but they have the inconvenience of giving off a bad odour, and particularly of staining the wool, and therefore much diminishing its selling price. The solution of sulphurated potash is only efficacious when concentrated, and then it makes the wool yellow, as well as hard and brittle.

In many countries, and especially in mountainous regions where the black hellebore is common, recourse is had to the rhizome of that plant, which is employed in decoction after reducing the fluid to two-thirds:—water, 1 litre; fresh rhizome, 125 grammes; or dry rhizome, 62 grammes.

We may, according to the local resources, substitute for the black hellebore either the green, fœtid, or white hellebore. In Germany, owing to the cheapness of tobacco, a good antipsoric decoction is made by boiling the prepared leaves of that plant in water, in the proportion of 200 grammes of tobacco to the litre of water.

These preparations are efficacious, but are scarcely suitable for a numerous flock. And the proper treatment of Sheep scabies really consists in the employment of antipsoric baths, the composition of which is somewhat varied.

To obtain all the results desirable from this treatment, the re-invasion of the parasites must be avoided. When the disease has existed in the flock for some time, it is well to disinfect the sheep-fold. All the manure should be carried to the dung-pit, as well as the soil, to a depth of four to five inches. All the woodwork—

doors, windows, hurdles and racks—should be dressed with boiling lye, then whitewashed to the height of a man. Brick or stonework parts should be scraped. Then the soil is to be replaced by new, which is to be well beaten down. Lastly, for two weeks the cleansed sheepfold is to be left vacant; after which, if scabies reappears, it will not be because of the sheepfold, but rather because the animals have been insufficiently treated. During this time the Sheep must be kept in another locality or park, and after being treated can be returned to their sheepfold. If the temporary locality is to be uninhabited for two or three weeks, it will be well to disinfect it; but if before that time there is occasion to put other Sheep in it, it will be necessary to submit it to the same operation as the sheepfold.

Before employing any remedies, the old writers prescribed scraping the diseased parts, and Delafond insists on the importance of this preliminary operation. It is done either with the *grater* of Daubenton, or with the *onglée* of Chabert and Fromage de Feugré. The first is a kind of knife, the blade of which is made of bone, and 1 mm. to 2 mm. thick. The *onglée* is an iron blade, bent at a right angle at one of the ends, which has a series of small teeth that are passed gently over the skin where it is covered with crusts; it has the inconvenience of causing bleeding. Many shepherds use their finger-nail in place of these instruments. But it is best to employ a simple blade of hard and flexible wood. The diseased part is scraped with the blunt edge, then rubbed with the side of the blade. This operation has the advantage of removing all the crusts, and with them a large proportion of the Psoroptes and their ova, crushing many of them, and rendering the action of the remedy more efficacious. The scraping and rubbing should be practised outside the sheepfold. But it may be noted that they are useless if the crusts are thin and few in number.

The Sheep should always be shorn before remedies are applied. But when scabies prevails at a time not favourable for this operation, Sheep-owners hesitate to cut the fleece which has only been growing for six or eight months, as its commercial value is then not so great. So most frequently the fleece is allowed to remain on until the proper time arrives; consequently, the effects of the treatment are incomplete. But it has at least the advantage of keeping the disease within certain limits, and allows of the usual shearing time being waited for without incurring much more damage.

Whichever may be the bath employed, it should not be given until four or five hours after feeding.

Exceptionally, animals whose skins are thickened like parchment ought to have a soap bath (soft soap, 1 kilogramme; soft water, 100 litres). This bath is given at a temperature of 30° to 35° (C.), in a tub large enough to plunge a Sheep into. The animal is immersed for about two minutes, then rubbed for another two minutes with a brush. This bath cleans the skin, softens the crusts, and frees the animal from a great number of parasites.

Next day the antipsoric bath may be given. If washing on the back has preceded the shearing, then the soap bath is useless.

Antipsoric Baths.—In France, the antisporic baths have arsenious acid for their base. *Tessier's bath*, which was proposed by that agriculturist in 1810, and which has been the most employed for a long time, has the following composition for 100 Sheep:

Arsenious acid - - - - - -	1·500 kilos.
Sulphate of iron - - - - -	10 ,,
Water - - - - - -	100 litres.

Boil for ten minutes.

The reactions which take place during boiling reduce the quantity of arsenious acid in solution to about 8·2 grammes to the litre of water (Rossignol). But the sulphate of iron is more especially a corrective, for it acts as an astringent, prevents the absorption of the toxic agent by the skin, and also hinders the Sheep licking. Numerous facts, published by Godine, jun., Gohier, Youatt, etc., show that arsenical baths, containing no astringent substance, may cause serious poisoning. Nevertheless, the result of experiments made at Melun in 1879, go to prove that *cutaneous* absorption is not to be apprehended in arsenical baths which do not contain more than 10 grammes to the litre of water, especially if immersion is not longer than five minutes; and that pure arsenical solutions, free from any astringent salt, may be employed if they do not contain more than 8 grammes to the litre of water.

The ferro-arsenical bath of Tessier has the inconvenience of giving a rusty colour to the wool, from its containing the sulphate of iron. Clement, in 1846, proposed replacing the iron by the sulphate of zinc in half the quantity—so that after boiling the proportion of arsenious acid fell to 9·504 grammes per litre (Rossignol). It is therefore more toxic than Tessier's bath. Mathieu, in 1856, substituted alum for the sulphate of iron to the same amount. The baths of Clement and Mathieu have given as good results as that of Tessier, and without staining the wool, as Delafond has stated; but they have not been employed so extensively. Besides, they are more expensive than the sulphate of iron, and increase the cost of the bath for 100 Sheep from fifteen pence—Clement's bath—to thirty pence—Mathieu's bath.

Tessier's bath has been blamed for serving in criminal attempts at poisoning, or giving rise to fatal mistakes on farms. Consequently, on the proposition of a committee of professors at the Alfort Veterinary School, a Ministerial Order decided that this bath should be coloured by the peroxide of iron, and made bitter by the addition of gentian powder, according to the following formula:

Arsenious acid - - - - - -	1,000 grammes.
Protosulphate of iron - - - -	5,000 ,,
Anhydrous protoxide of iron (colcothar) - -	400 ,,
Powder of gentian-root - - - -	200 ,,

This was the only preparation druggists were authorized to sell, and represents the quantity for 100 Sheep, when boiled in 100 litres of water. But the formula has become obsolete, and is replaced by that of the *Codex* of 1844, given under the name of 'Trasbot's Arsenical Bath,' in which the astringent is represented by the sulphate of zinc and the bitter substance by aloes, which, as Delafond has well demonstrated, may advantageously take the place of gentian. The following is the formula of the *Codex*, the quantity being sufficient for 100 Sheep :

Arsenious acid	1,000 grammes.
Sulphate of zinc of commerce	5,000 ,,
Aloes	500 ,,
Water	100 litres.

Dissolve the arsenious acid in 20 litres of boiling water, also dissolve the aloes and sulphate of zinc in 10 litres of cold water ; then mix the two solutions, and add the remainder of the water.

The price of this bath amounts to about fifty pence per 100 Sheep, and though a little dearer than Tessier's bath, it has the advantage of not staining the fleece, while it is as effective in curing the disease ; as it is Clement's bath, only rendered bitter and coloured by aloes—the good effects of this bath being testified to by Delafond and numerous practitioners. According to the statistics collected by Delafond, dealing with 36,000 Sheep, treated from 1816 to 1852, 35,963 were cured by Tessier's bath, the remaining 37 having succumbed from anæmia and marasmus before treatment ; only 60 Sheep required a second immersion to make the cure a radical one.

Beucler has made known an interesting case, in which, of fifty-one Sheep dipped in Clement's arsenical bath, forty-nine died in less than twenty-four hours. The expert showed that the sulphate of zinc had been replaced by the *sulphate of soda*—a mistake of the druggist. Consecutive experiments made by Nocard appeared to establish that, in animals, the absorption of the poison had taken place by the surface of the skin.

The following recommendations have regard to the manner of employing arsenical baths :

As has been already said, the animals should be shorn as much as is possible. This precaution—which is always useful, in order to ensure the effects of the bath—is necessary if the primitive bath of Tessier is had recourse to, as it depreciates the fleece by the coloration it gives.

The bath is kept always tepid—30° to 35° (C.). The temporary locality in which the Sheep are kept should be divided into two spaces by hurdles—the animals passing from one to the other as they are dipped. At least four men are employed in the operation —one to bring the Sheep, and three to dip it, two of these having a coarse brush.

Tessier expressly recommends that the hands of the dippers be provided with leather gloves ; but experience has shown that this

precaution is needless, as men may be employed in this work for twenty-four hours, and even for several consecutive days, without any harm occurring—the epidermis of the hands and arms merely becoming dry, as if tanned, and rust-coloured in the Tessier bath, this tint disappearing promptly if the parts are washed with a weak solution of hydrochloric acid, which may also be employed to remove the iron stains on the clothes made during the dipping. But notwithstanding the numerous favourable experiments, men who have wounds on their hands should abstain from taking part in the operation.

The udder—and more especially the teats of the milch ewes, should have been previously smeared with grease, to prevent the astringent action of the fluid, which otherwise would diminish the secretion of milk for some days. The other animals of the flock *do not* require any preparation.

Each Sheep is kept in the bath for two minutes, the entire body being immersed, except the head; though in the case of very mangy animals particular care should be taken that the fluid penetrates all the folds of skin on the head, in the arms, flanks, and between the claws. After one or two minutes, the animal is placed standing in the bath, and brushed and rubbed over every part, and especially the mangy places—but without causing them to bleed—for from two to five minutes *at most*. The same procedure is carried out on the limbs and nude parts of the head, where the Psoroptes often take refuge. The dippers then pass their hands over the body to press out the fluid, the Sheep is set free in the place set apart for the dipped animals, and the operation is terminated.

Four men can dip from 12 to 14 Sheep in an hour, or 120 to 130 in a day.

Tessier recommends putting the ears over the eyes of the Sheep while in the bath, to prevent the fluid entering the ears and injuring the eyes; but Delafond considers this precaution useless, as the bath does not cause any irritation to these organs.

What remains in the bath is kept for local application, in cases that require a second dressing; and when the disease has completely disappeared, the surplus fluid is buried in the ground.

The caldron in which the fluid has been heated should be carefully washed out, as well as the bath-tub, buckets, brushes, and other articles used in treatment.

Tessier recommends leaving the Sheep for twenty-four hours in a place without litter, straw, or forage, so as to avoid impregnation of these with the fluid that drips from the animals, and to prevent accidents by poisoning; but Delafond assures us that they rarely show any tendency to take food which is made bitter, and that when fed for three to eight days on food containing every day from one to three centilitres of Tessier's bath, they did not suffer any harm. He also found that animals which were dipped in this bath, and whose wool and skin were moist with it, did not lick themselves; or if they did so, they did not swallow sufficient poison to do them

any injury; for in his experiments Sheep have taken from two to ten centilitres of this fluid without being indisposed, and it required a dose of five decilitres to induce fatal poisoning.

When taken out of the bath, it is observed that the parts denuded of epidermis, and the cracks and ulcers, are cauterized. In three to four hours afterwards there is general febrile excitement—often scarcely perceptible—which persists in a more or less marked manner for ten or twelve hours.

From the third to the fifth day the skin is hard, difficult to fold, and covered—especially at the mangy parts—by a sedimentary adherent crust, which is rust-tinted if Tessier's bath has been used. The animals no longer rub or scratch themselves, and have an excellent appetite. In the crust, the microscope only reveals dead Psoroptes, and dried and withered eggs.

From the eighth to the twentieth day, numerous crusts become detached, showing the cicatrized, rosy skin, which is thin and supple. In the parts which were badly affected, the latter result is only attained towards the thirtieth, and even the fiftieth day. The wool grows soft and shiny, and the reddish tint at the end of the locks disappears from day to day, while the animals quickly regain their liveliness and condition.

Sometimes, though rarely, the disease reappears in some animals at certain points; but scraping, and the application of one or two dressings with the bath fluid, will suffice to effect a complete cure.

The process of cicatrization in the affected parts often produces intense pruritus, which must not be taken as an indication of persistence of the malady; it is well, nevertheless, to watch the Sheep carefully during this period, and to be assured that the diseased places are really recovering.

The cure of scabies is all the more rapid the less constitutional disturbance there is. It is realized in about eight days, when the skin is not greatly altered. In other instances the cure is subordinate to the reactional power of the animals; and it may be remarked that, according to the observations of Cagnat, the antipsoric baths are injurious to cachectic Sheep, and may cause their death.

Scheuerle and Kehm employ an arsenical bath which they consider the best, with regard to efficacy and rapidity of cure; it leaves the wool of a fine white colour, and never causes poisoning if the precautions they give are adopted. It is composed of:

Arsenious acid	500 grammes.
Alum	6,000 ,,
Water	100 litres.

The Sheep are dipped in the open air. There are two iron caldrons of 20 to 24 litres capacity, which are filled with water and placed on a fire; two other caldrons of about 30 litres capacity, not quite full of water, are also heated. In the two first caldrons is

put the arsenic, which, by reason of its density, sinks to the bottom; but after boiling and stirring for fifteen to thirty minutes, it is completely dissolved, and the fluid has the limpidity of water. At the same time the alum, broken, is thrown into the boiling water in the larger caldrons, and is concurrently dissolved. The two solutions are then poured into a tub or bath, and cold water is added sufficient to make up the amount stated in the formula. To dip 200 Sheep recently shorn will require 2·500 kilos of arsenic, 25 to 30 kilos of alum, and a corresponding quantity of water.

A quantity of the solution sufficient to cover a Sheep is placed in the bath; a man takes the Sheep by the fore-legs and crosses them on the neck, while a second man seizes the hind-legs and turns the animal over on its back; the creature is then immersed for two minutes, the eyes and mouth being kept out of the fluid. On removal, it is put into an empty tub, and three men rub and brush it vigorously, squeezing out the fluid remaining in the fleece. To protect themselves from the corrosive action of the fluid, if long employed at this dipping, the men frequently soak their hands in linseed-oil. One of them is occupied with the head of the Sheep, which had not been moistened; he holds in one hand a basin containing a quantity of the solution, while with the other hand he applies this all round the head, taking care not to allow it to get into the eyes. The very mangy parts are scraped, so as to remove the crusts. When all the Sheep have been dipped, they are set at liberty in an enclosed place for some hours, in order to facilitate evaporation, but without exposing them to a hot sun or a dry wind.

There is a tendency to replace the various antipsoric baths by creolin baths, and this preference is justified by their efficacy, their innocuousness with regard to health and the quality of the wool, the facility with which they can be employed, and their cheapness. Trials of them have been more particularly made in Germany, and their use is officially prescribed in Prussia. Shearing having been carried out as much as possible, the crusts are softened by rubbing the most diseased places—neck, back, and croup—with a liniment composed of soft soap, 8 parts; creolin, 1; alcohol, 1. The bath is afterwards prepared for 100 Sheep, as follows: water, 250 litres; creolin, 6·500 litres. Every Sheep undergoes two dippings at an interval of seven days, each dip consisting in an immersion in the bath for three minutes, followed by a good brushing for the same time, and a second but brief immersion. Each Sheep requires about 2 litres of the solution. It is, of course, understood that the general rules applicable to antipsoric baths are as important in regard to this one. The value of the creolin bath has been many times recognised, and Hohenleitner and Gsell have quite recently confirmed the reports as to its utility.

Walz's Bath.—The oldest bath employed is that of Walz. Hering and Hertwig have particularly recommended it, and it is still in frequent use in Germany. It is composed of:

Slaked lime	4	parts.
Carbonate of potash	5	,,
Cow's urine		q.s.
Dissolve by boiling, and then add :		
Empyreumatic oil	6	parts.
Vegetable tar (or coal tar)	3	,,
Mix perfectly, and dilute the whole with :		
Cow's urine	20	,,
Water	800	,,

One hundred litres are sufficient for 100 Sheep. The dipping requires to be repeated three times at least, sometimes four and five, at intervals of eight days, in order to ensure a complete cure. This bath is therefore inferior to the preceding preparations. The three parts of tar are usually replaced by two parts of the carbolic acid of commerce.

Zundel's Bath.—Zundel has devised a special bath, the formula for which has been inspired by the energetic acaricide action of pyrogenous substances, such as were employed in the comparative experiments of Hertwig, Gerlach, etc. 'Our system,' he says, 'is really economical, as it does not cost more than twopence per head, and is a certain cure, often after only one bath. This is composed of crude carbolic acid, 1,500 grammes ; quicklime, 1,000 grammes ; carbonate of soda, 3,000 grammes ; soft soap, 3,000 grammes. These substances, on being mixed, form a thick paste ; this is diluted, when required for use, in 260 litres of hot water—which makes a sufficient quantity for 100 previously shorn Sheep. With this rational imitation of Walz's bath, in which there is formed a caustic soda that dissolves the carbolic acid, the Sheep are washed by means of a strong brush—of dog-grass, and by plunging them in the solution, which is placed in a large tub. Two men and two assistants are sufficient for the operation. Sheep which are badly affected should be washed again in four to six days.' The caustic soda which is formed in this preparation dissolves the crusts and the Psoroptes they conceal, and also dissolves the shell of the parasites' eggs ; but it slightly irritates the hands of the operators. Zundel asserts that, with the degree of concentration of this bath, there is no fear that the soda will saponify the yolk, and, corroding the wool, render it dry and brittle. He prefers the crude carbolic acid to the pure article, as the essential empyreumatic oils in it are also useful.

Tobacco.—In Germany, the relatively low price of tobacco and its certain acaricidic action causes it to be often employed for the treatment of Sheep scabies. It was strongly recommended by Gerlach, and the following is the manner of applying it, as indicated by Zürn.

An alkaline bath is first given, composed of 4 kilos of potash, 2 kilos of lime, and 100 litres of water. The next day the antipsoric bath is given ; this is made of 15 kilos of ordinary tobacco to 110 litres of water. One to two litres are required for each clipped Sheep, and double the quantity in winter when the wool is

long. Each animal is kept in the bath for three or four minutes, the head being plunged in it several times, and the creature's eyes protected by the hands. The Sheep is then placed on its feet in an empty tub, where all the superfluous fluid is squeezed out of the wool. This fluid is returned to the dipping-tub. The manipulations are otherwise the same as for the arsenical baths.

These tobacco baths are limited in their action to the living Psoroptes. The eggs remain intact, and are hatched; so that the parasites from them should be destroyed before attaining the age of reproduction. This is why a second antipsoric bath is required in five, six, or eight days after the first. If there are many crusts, it is advisable to give a second alkaline bath; and in some cases, in which the pruritus continues, it is requisite to administer a third, and even a fourth, tobacco bath.

Ostertag has modified this treatment in the following manner: Employing by preference the juice of tobacco, because of its low price, he makes a decoction of 5 kilos of tobacco in 250 litres of water, adding—after he has dissolved them separately—3 kilos of common soda, the same quantity of soft soap, and 1,500 grammes of quicklime, and the same quantity of crude carbolic acid. Ostertag has also successfully employed a bath composed of water, 250 litres; pure carbolic acid, 1 kilo; potash, 1 kilo; and tobacco, 7·500 kilos.

Because of its originality, we may here mention the manner of treating the disease in the Pampas of the Argentine Republic, in flocks of 2,000 to 2,500 Sheep.

The shepherd, a gaucho on horseback, drives the Sheep towards a palisaded enclosure ending in a narrow passage, through which they are obliged to defile, one after the other, the space being too small to allow two to go through at a time. This passage is continuous with a kind of trench in wood or masonry, with a sloping entrance and exit, which is filled with the antipsoric bath. The Sheep, not being able to turn round to escape, has to pass through this wet ditch, and so is gradually immersed deeper and deeper until up to the neck in the fluid. The animal finds its way out by the opposite slope, with its fleece impregnated by the fluid. The operation is very simple, and scarcely occupies more than an hour for the whole flock. The curative agent is tobacco or its refuse.

It is recognised in Britain, that the treatment of Sheep scabies, to be satisfactory, must be cheap, simple, and readily and quickly practicable; while it must neither hurt the Sheep nor their wool, or the men who apply the remedy. It may beneficially continue in the fleece for some time after application, so that it can destroy the young acari as they are hatched from the eggs, which have escaped destruction or removal; as most applications require repeating after a few days, and sometimes even a second or third dressing is necessary. The methods which have been found practicable are *dipping*, *smearing* or *salving*, and *pouring*. 'Dipping' consists in the thorough immersion of the Sheep in the acaricide fluid contained in a bath—or a dipping-well in some cases; and its proper performance depends on the adoption of a number of precautions, and exercise of the greatest care. The liquid used varies much in

different cases and countries; every chemist has his formula for a 'Sheep-dip,' ranging from McDougall's compound and Tuson's equally valuable soluble mixture, to the empirical preparations of local country chemists, and the ancient recipes in possession of shepherds and farmers.

In Australia, 'Sheep-dipping' is carried out on a very extensive scale. There are generally two yards—the receiving and forcing yards—usually of a circular form, which turns to advantage the habit which Sheep have of 'ringing' when disturbed in a yard, and saves labour of men and dogs; as the Sheep cannot 'pack' or stop, however much they may try. It is recognised as advisable to have the exit of the yard near to the entrance, as the instinct of the Sheep impels it to escape by the opening through which it entered. If the Sheep are tardy in moving on, a man jumps over the fence and runs through the flock in a direction opposite to that in which they are required to pass; this will start them at once. There must be several yards in series, so that too many Sheep are not in any one of them at a time; from the last yard to the dip there must be a path or race, 2 feet 3 inches wide, and 20 feet long; the last 5 feet being smooth, and at an incline of 25° to 30°, in order that the Sheep may slide along it into the dip. These yards can be used for drafting purposes, after being disinfected, by simple modifications. The race and commencement of the dip should have high fences, to prevent the Sheep jumping out. Around the dip should be a stage from which the Sheep can be thrown into the dip, either by men or by means of a tilt. The Sheep on the race and stage should not be allowed to see the dip, nor those in the yards be able to see the stage and dip. Decoy pens may be placed in such a position that the Sheep coming up see those in these pens and suspect nothing; this economizes much time. A slide gate separates the race from the dip, and is better than simple hurdles for the purpose.

Three kinds of dipping apparatus are used in Victoria and South Australia:

1. Round, 9 feet in diameter, and 8 feet deep in the clear, having a drawgate 4½ feet wide at the commencement of the race from the dip into the draining yard, which race is 10 to 15 feet long by 4½ feet wide, commencing at 2 feet from the bottom of the dip, and gradually rising to the level of the draining yard.

2. Oblong, 20 to 25 feet long, by 4 feet long at the stage end, gradually narrowing to 2 feet 3 inches at 12 feet from the end of the stage, remaining that width to the race to the draining yard, which is 2 feet 3 inches wide and 10 to 15 feet long.

3. This is employed with circular yards, and is similar to No. 2, but is 2 feet 3 inches wide throughout. The dip is made of pine, tongued and grooved, or of colonial timber, sawn or in slabs. Around the race and dip should be puddled to a thickness of 2 feet if colonial timber be used, and the slabs should be secured with stays attached to posts in the ground behind the dip. The depth and contents in gallons should be indicated by a plainly-marked

scale on the sides. There should be a depression on the side next to the boilers to collect the mixture. Both dip and draining race should have watertight covers. The draining yards—which may be two in number, each for 200 to 300 Sheep—and the gangway which leads to them, should have battens so arranged as to allow the drippings to flow back into the dip.

The tobacco and sulphur dip is used. Infusion boilers with air-tight covers must have one pound of tobacco to five gallons of water, and the infusion is made as if making tea—it is allowed to stand for eight to ten hours—then fresh water may be boiled with the tobacco for two hours, and this may be drawn off and a second boiling tried, after which the tobacco is exhausted. A measure, consisting of a cask gauged and marked, lies on the tube running from boiler to dip, and serves to measure the quantity of water passing in. The sulphur water must be thoroughly mixed with the tobacco infusion.

Six men and the overseer are required for the operation—one to the yard, two to throw in the Sheep, one to the boilers, and two men armed with crutches, consisting of a 7-foot handle attached to the middle of a head 12 inches long, made of ½-inch round iron, bent so as to either pull or push.

The dip is filled to within 12 inches of the top, and each Sheep is made to swim round the No. 1 dip at least twice, but with Nos. 2 and 3 swimming the whole length is sufficient. By means of the crutches each Sheep is made to pass at least twice completely into the solution.

The overseer at the drawgate of the draining gangway passes each Sheep as sufficiently dipped. Care has to be taken to keep up the strength and temperature of the bath; it should not be allowed to fall lower than 2 feet 3 inches from the top, lest the Sheep's legs be broken against the bottom when they are thrown in With a short fleece the bath should be at 110° Fahr. in winter, 100° in summer, and the Sheep ought to remain in it for about a minute. If the bath is colder they must be kept in longer, but the temperature of it should never be less than 85° Fahr.; with a long fleece, 90° to 95° in summer, and 95° to 100° in winter, will suffice, and each may be kept in a little shorter time, as it will take longer to drain.

Another method of Sheep-dipping, given in a Scotch newspaper, is of interest: The dipping apparatus may be in the form of a pond or trough, and may be fixed or movable. It should be narrow and deep to economize the liquid, and narrower at the bottom than the top. It should not hold more than 80 to 100 gallons of fluid; if for flocks of thirty to forty score a movable dip capable of containing 50 to 60 gallons will be sufficient. One end of the trough should slant, to facilitate lifting of the Sheep on to the drainer, and should be fitted with battens to enable the animal to walk up when turned on to its legs by the shepherd, who lifts the head, while his assistants leave the hind-legs free and lift the fore-quarters. The

trough should be freely washable and have a ready outlet, and water ought to be constantly kept in it to maintain it water-tight. The drainer is a wooden or metal grating on a wooden channel inclined towards the trough, sufficiently large to accommodate forty or fifty Sheep at once, surrounded by a railing, and divided into halves, each with a gate of entry and one of exit, the latter being furnished with a sliding-board to prevent injury when the Sheep are lifted off the drainer. The dipper should have beside him a stool or inverted pail, on which to turn the Sheep, to prevent rough and hurried handling. Not fewer than six men are required for the movable apparatus, and four for the fixed. One catches the Sheep, the shepherd holds the head, two men seize the legs and turn the animal into the bath; two more men hold it on the drainer. Two enclosures should be to hand, one near the apparatus for three or four Sheep, and a larger for fifty Sheep. The fixed dipping apparatus may be paved, and roofed to keep out the rain.

The bath fluid should be of extra strength rather than weak, and it ought to be at a temperature of 80° to 95° Fahr. Not more than fifty Sheep per hour should be dipped; six men can dip 500 animals in a day, giving two or three minutes' immersion for each. A good dip is composed of: Sulphur, 20 parts; quicklime, 10 parts; water, 100 gallons. Boil for two hours in a fourth of the water, and add more water as required. Finally, dilute the product to 100 gallons, and use after precipitation of the sediment.

3. *Chorioptic Scabies.*

This form has been observed by Zürn and by Schleg. The Choriopt is similar to that of the Horse, of which it is a variety—*Ch. symbiotes*, var. *ovis*—though of smaller dimensions than the type.

Like the symbiotic scabies of the Horse, this is principally located on the limbs—in the hollow of the pasterns of fine-bred but neglected Sheep, especially the Negretti breed. And like the Horse Chorioptes, those of the Sheep emigrate with difficulty from the region they have invaded, and only slowly ascend towards the upper part of the limbs. The scabies they produce is very slightly contagious, and in a flock there is only a small number of Animals attacked—sometimes no more than one per cent. Zürn is inclined to ascribe an important share to predisposition and immunity in the etiology of the disease.

At its commencement, this scabies is characterized by the redness of the skin and an abundant epidermic desquamation; later, there appear pale-yellow crusts. The pruritus is somewhat severe—the animals stamping, rubbing and gnawing the affected parts, and so giving rise to an exudation, and the formation of crusts varying in thickness; while cracks, more or less deep, appear about the pastern. Numerous Chorioptes—among which the males are nearly as abundant as the females—burrow beneath the crusts. The shepherds considered this eruption was due to food too rich in salt, because they observed it when the Sheep were stabled in winter. The hind limbs are first affected, then the fore ones, and the scrotum in the ram, the mammary region in the ewe. The body, neck and head always remain free from it.

This form of scabies is not serious, and always disappears with simple cleanliness. In any case, it readily yields to antipsoric treatment.

Goodall, Christchurch, Hants, has recently discovered this parasite on the feet of Sheep, and he believes it occasions one of the forms of foot-rot, as he has discovered it where that disease was prevalent. He has found it in abundance—the males being very few—around the upper part of the claws, in the sebaceous follicles, and more especially on the interdigital skin and in the sinus there. He states that, in his experience, glycerin kills the Acari immediately they come in contact with it. To observe them and watch their movements, he makes a thin circle of Canada balsam on a slide, places the parasites within it, and puts a covering glass over them. They may then be observed alive for hours, and it will be noticed that the animalcules always spread out their legs in good positions as the cover-glass gradually falls on them.

D.—Scabies of the Goat.

On the Goat are found Sarcoptes, Psoroptes and Chorioptes. But up to the present time only two forms of scabies have been observed—the sarcoptic and chorioptic. The Psoroptes have only been seen in the pavilion of the ear, producing a benign acariasis, which will be studied when the diseases of the sensory organs are dealt with. The Goat, to judge by the experiments of Delafond, cannot contract psoroptic scabies; as he vainly tried to transmit the ordinary scabies of Sheep to that animal, by placing on its skin numerous Psoroptes taken from scabied Sheep.

1. *Sarcoptic Scabies.*

Among Thibetan Goats imported into France in 1818, through the instrumentality of Huzard, and in 1819 through the action of Joubert and Ternaux, a large number were affected with scabies, and many of these died. It is difficult to say if the disease was due to the sarcoptic or the chorioptic form; but there can be no doubt as to this with regard to the scabies of a Perisan Goat, the history of which was published by Henderson, for its disease was communicated to men and horses in the form of sarcoptic mange. And so it was with the epizoötic scabies that affected the Goats in the valley of Prättigau, canton of Grisons, Switzerland, in 1851, 1852, 1853. Though Wallraff, who observed it, did find the acarus, the contagiousness of the malady with regard to Man, Horse, and Sheep, and its clinical characters in these, well demonstrated its sarcoptic nature. But it was Franz Müller, of Vienna, who first—in 1853—found Sarcoptes on the dwarf Goats of Africa, and Hebra considered them identical with those of Man. Fürstenberg studied them, and concluded that they were a distinct species—*Sarcoptes capræ*; and Roloff, who also undertook their study, regarded them as the *Sarcoptes squamiferus* of Fürstenberg. But it is more just to name the parasite *S. scabiei*, var. *capræ*.

Symptoms.—From its commencement to its termination, the disease is characterized by great itching. It begins at the head and ears, reaches the trunk and abdomen, the mammæ, and finally the limbs—appearing at first in the form of small pimples, from which a viscid fluid exudes, and soon produces dry, scaly crusts, sometimes furfuraceous, sometimes great thick plates of a shining bluish-grey tint. The hair falls off; the skin becomes thickened, dry, ridged, cracked, and adherent; and the nose and lips are tumefied. Numerous Sarcoptes are found under the crusts.

At first limited to a few restricted patches, the malady, if left to itself or insufficiently treated, becomes generalized, and causes rapid emaciation, which may terminate in death.

It is capable of assuming an epizoötic character. Wallraff remarked that, after the disease had shown itself in some communes of Prättigau during the summer of 1851, it extended in such a manner that in the spring of 1853, in ten communes, containing 2,596 Goats, 1,015 were affected and about 250 died. When the epizoöty had subsided, the total loss amounted to about 500 animals. Klingau reported 100 deaths in a year in one commune.

Etiology, Contagion.—The relatively few observations published with regard to sarcoptic scabies of the Goat show that it attacks, by preference, breeds of Asiatic or African origin. The only exceptions to this are the outbreaks recorded by Wallraff and Klingau, in which the diseased animals belonged to the local mountain breeds. In the instance recorded in the *Comptes rendus* of the Lyons Veterinary School, they were Thibetan Goats ; in that reported by Henderson, it was a Persian Goat ; in that mentioned by Müller, they were dwarf Goats from Khartoum ; and it was in a fat-tailed ram from Africa that Roloff first saw it.

The scabies of that ram was transmitted to a male Goat, which died from it. And it is not impossible that the sarcoptic scabies of the Goat had its origin in the psoric form of *noir-museau* of the Sheep. An experiment made by Railliet would tend to demonstrate this, as he was able to communicate a generalized and fatal scabies to a Goat by means of the Sheep sarcopt.

Inversely, this scabies of the Goat is transmissible to the Sheep, on which it is localized on the head, as in the natural form of sarcoptic scabies of that animal. It is only in breeds with dry wool, poor in yolk—like the Zackel breed and the Somali Sheep—that it may extend to the other parts of the body, where the wool is scanty and coarse.

In Henderson's case, the Goat disease was conveyed to men, who were considered as suffering from itch by the doctors attending them. It was the same in the epizoöty at Prättigau, where the itch, transferred to the people, assumed a particularly severe character. Horses were also infected in these two instances, and in that alluded to by Wallraff the malady extended also to the Cattle and Pigs. A herd guarding the Goats observed by Müller, was attacked on the hands by an eruption of itch, which was cured by sulphur ointment. Roloff has also collected a number of instances of pure itch occurring in people who had been in contact with his scabied Goats. On the other hand, in his experiments he could not succeed in implanting this Goat mange on other animals except short-woolled Sheep—Somalis—or Sheep with scanty wool—fat-tailed Sheep. With Merino Sheep, the Pig, Dog, Ass and Rabbit, he only obtained a very ephemeral scabies, or absolutely negative results.

Treatment.—In cases in which flocks of Goats are affected, the

treatment by antipsoric baths—as in the psora of the Sheep—is applicable; but it is attended by greater difficulties, owing to the greater vivacity of the Caprine species. Wallraff was completely successful with Walz's bath, which was followed by an ointment having sulphur and soft soap for its base. But some of the Goats plunged their head in the liquid, swallowed some of it, and died from poisoning.

For isolated cases, after clipping off the hair, recourse may be had to one of the antipsoric applications already mentioned for the sarcoptic scabies of the Horse.

2. *Chorioptic Scabies.*

This scabies was studied by Delafond in the Jardin des Plantes, Paris, on Angora Goats in 1854. He recognised the parasite as belonging to the genus he named *Sarco-dermatodecte*—the Choriopt.

Railliet observed—even on Delafond's preparations—that the male of this variety had many of the foliaceous bristles indicated by Mégnin as characteristic of the Choriopt. Mollereau has recently witnessed an altogether peculiar instance of this psora.

The Chorioptic scabies studied by Delafond began on the sides of the neck, behind the ears, on the withers, the back and loins, and sometimes at the root of the tail—more rarely on the sides of the chest and at the flanks. It produced more or less extensive, though at first incomplete, depilations, attended by shedding of the wool alone and persistence of the long hard hair. Yellow, hard, thick and coarse crusts form, which are very adherent; and beneath them the skin is hypertrophied, dry, wrinkled, cracked and adherent. The Chorioptes are always beneath the crusts, and especially those of recent formation. The lesions of the skin induce tumefaction of the neighbouring lymphatic glands.

The wool of the Angora Goats becomes matted and falls off in locks, the hairs of which are dirty at the roots, and have lost their elasticity, softness and lustre; so that combing is difficult, and there is much waste. At those points where the disease is very old, the fibres of the wool are short, thin, and atrophied, very fine at the end, and much intermixed with the hairs proper.

This scabies has a slow course, and may remain for two or three months confined to the sacro-lumbar region; it is only after that period that it has descended to the chest and flanks, and on the limbs to the knees and hocks. It does not affect the face, ears, testicles, mammæ, tail, or lower part of the legs.

In the instance recorded by Mollereau, the scabies was localized on a hind-pastern, and was manifested by a hard ring which had compressed the neighbouring parts, producing an œdematous swelling, and even commencing necrosis of the skin. This thick crust was formed by shreds of straw agglutinated by serosity; its inner surface covered a multitude of the *Chorioptes*.

The treatment followed by Delafond consisted in clipping off the wool, then employing alkaline baths—about 5 to 10 pounds of carbonate of potash or soda to 22 gallons of water. The concentration of the fluid is subordinate to the thickness of the crusts, and the immersion is for a quarter of an hour, being accompanied by vigorous rubbing. 'Two or three baths, and four or five rough rubbings, at four or five days' interval, are sufficient to effect a cure.' Delafond advises, in addition, local applications of Helmerich's pomade, oil of turpentine, tar, etc.; but every kind of convenient antipsoric treatment, judiciously applied, will yield good results.

E.—Scabies of the Pig.

The Pig has only one kind of scabies—the sarcoptic form—due to the *Sarcoptes scabiei*, var. *suis*; the *S. squamiferus* Fürstenberg. We cannot admit that there are two kinds of sarcoptic scabies, due to two different varieties of *Sarcoptes scabiei*. This distinction has been made by Mégnin after an incomplete examination of Delafond's description, and of too brief notes supplied by Guzzoni. One of these forms was scabies of the trunk, the other that of the ears, and the sarcoptes which caused them differed in size; the one must have been the *S. sc. suis*, and the other was mistaken for the *S. sc. hominis*. Our notice of Pig scabies will show our reasons—until better informed—for rejecting this distinction.

It was a long time ago described by Viborg, but search for the acarus producing it was unsuccessful. In 1847, Gurlt and Spinola had certainly found a Sarcopt in the scabies of a wild Boar, and some years afterwards the same experience occurred to Hertwig and Gerlach; but all failed to find the parasite on the domestic Pig. It was Delafond who, in 1857, discovered it at Alfort on two young Pigs of the Anglo-French breed, and intended for surgical operations. Subsequently, Müller, of Vienna, in 1864, and Kocourek, in 1865, found this Sarcopt on Chinese Pigs. We have also seen this scabies at Toulouse, affecting a Yorkshire sow and her progeny.

Symptoms.—This scabies begins with a violent pruritus. It appears to be at first localized on the head—chiefly on the ears and around the eyes, then at the withers, croup, and inner surface of the thighs; later it invades the entire surface of the body. In recent cases, no galleries are observed, but only some red, closely-set papules. The morbid secretions and the abundance of epidermic cells cause the formation of dry, whitish-grey, lustrous crusts, which are adherent while yet thin, but easily detached when not so, and sometimes attaining a thickness of 5 mm. to 10 mm. The skin is wrinkled, and the bristles are either shed or pushed from their follicles: they lie on the surface of the integument, agglutinated into small tufts, to fall off afterwards. The crusts are more or less extensive, according to the age of the disease. Frequently the whole head is invaded, and even the greater part of the trunk, when the animals look as if powdered with dry guano, according to the remark of Müller. Beneath the crusts the skin is excoriated and cracked, especially at the bottom of the wrinkles; and on the chest and abdomen it may become 3 cm. or 4 cm. thick. In the other regions—and particularly at the base of the ears—the hypertrophied papillæ form tubercles from the size of a pea to that of a bean, which may be compared, for shape and dimensions, to the papillæ on the Ox's tongue, or the warts on a Cow's teats or lips of the Dog. These hypertrophied cutaneous papillæ are embedded in the crusts, beneath which the Sarcoptes are found.

In order to discover the parasites, it is sometimes necessary to scrape the skin to the quick, and even then the search will often be without result; this explains the non-success of the earlier

investigations. The size of the parasites renders them perceptible to the naked eye, and especially if a pocket lens is used. They are the largest variety of the *Sarcoptes scabiei*, the ovigerous female measuring from ·40 mm. to ·50 mm. long, and ·32 mm. to ·39 mm. broad; while the male is ·25 mm. to ·35 mm. long, and ·19 mm. to ·30 mm. broad. Guzzoni found some, in scabies of the ears, the dimensions of which were about those of *S. scabiei*, var. *hominis*, the ovigerous female being ·30 mm. long, and ·26 mm. broad; and the male ·20 mm. long, and ·16 mm. broad.

Swine scabies progresses slowly. When it has invaded a large surface of the body, it hinders fattening and gradually causes marasmus.

Etiology, Contagion.—This scabies appears to be rare, although it is stated to be relatively frequent in Holland, and more prevalent in the centre and west of France than in the other parts of the country. It is possible that, as Viborg asserts, excessive misery and uncleanliness are the predisposing causes.

Contagion is evidently the only efficient cause, though it does not appear to be alike for all animals; for it has been already shown that the disease has been more particularly studied on Pigs of improved breeds; and it has been observed that young Pigs of common breed have been in daily contact with those of English breed—which contracted the disease from their parents—without becoming infested. There is nothing in the accounts of this scabies which allows of the disease being traced to its source. 'It is not rare,' says Viborg, 'for Pigs to take the mange from burrowing in the manure of mangy Sheep, Cattle and Horses.' This is a bold assertion which experiments do not justify, as Gerlach has inoculated Pigs with Sarcoptes from the Horse and Cat, with a negative result; and according to Spinola, the Sarcopt of the wild Boar only will, when transferred to the domestic Pig, cause mange.

The scabies of the Pig is contagious for Man, as the clinical observations of Bateman, von Gemmern, Bontekoe, and Heckmeyer — quoted by Delafond and Bourguignon — prove; but the eruption disappears spontaneously in about five days. Depositing the Sarcoptes of the wild Boar on the arm of Man induces an exanthem which disappears in eight to ten days (Gerlach). Delafond contracted the disease in studying and dissecting the skin of an affected Pig; the malady progressed slowly, and it was only towards the thirtieth day that it threatened to become generalized, when Delafond cured himself with Helmerich's pomade. At the Dresden Veterinary School, two students, by means of a bandage, fastened on their arm a piece of diseased skin from a mangy Sow, and there resulted a very pruriginous itch that, in one of them, subsided of itself in about forty-eight hours; but in the other had to be treated by creosote ointment.

Scabies of the Pig is transmissible, according to Viborg, to all the domesticated animals; but Am-Pach—quoted by Gerlach—states that it is only communicated to the Dog. At Dresden, a fragment

of the skin of a mangy Pig was fixed on the neck of a Dog; this gave rise to a violent pruritus that reached its maximum in about forty-eight hours; then it gradually subsided, and on the eighth day had disappeared. The same experiment made on the back of a Sheep was absolutely negative; but the proof would have been more convincing if the attempt had been made on the face of the Sheep, which is the seat of the sarcoptic scabies special to the ovine species.

Treatment.—The disinfection of the pigsties is a necessary prophylactic measure. Treatment consists at first of alkaline baths accompanied by vigorous friction, so as to remove as many of the crusts as possible. As an antipsoric remedy, Viborg has recommended a decoction of 30 grammes of tobacco in 2 litres of water, to be reduced to 1 litre. In the case of chronic and extensive disease, Delafond counsels several hard rubbings with Helmerich's pomade, or with a mixture of oil of turpentine 8 parts and flowers of sulphur 1 part. The use of Helmerich's pomade has given us an easy and complete success in the case of a Sow and her litter.

F.—Sarcoptic Scabies of the Rabbit.

We have already seen that, in the fur of the Rabbit, we may find three kinds of microscopical Acarina not belonging to the psoric Sarcoptidæ, and, rarely causing cutaneous lesions. These are the Gamasus pteroptoïdes (p. 99), the Cheyletiella parasitivorax (p. 103), and the Listrophorus gibbus (p. 105). Independently of these Acarina, a Sarcopt and a Psoropt live on the head of the Rabbit and produce two diseases—a sarcoptic scabies, and a psoroptic acariasis having its seat in the ear. The latter will be studied hereafter, when the parasitic maladies of the sensory organs are considered.

Gohier asserted that he had seen this scabies on the domestic Rabbit, and discovered the parasite. Huzard has given a description of the affection; and Gerlach also describes it, and gives a figure of the parasite, which he names the *Sarcoptes cuniculi*. We have already said that it belongs to the *Sarcoptes minor*, var. *cuniculi*—it being so placed by Fürstenberg. Railliet has had occasion to study this scabies.

Symptoms.—Sarcoptic scabies at first affects the nose, then the lips and the forehead. Gerlach has never seen it extend beyond this; but in a Rabbit which died from it, Railliet noted that, after the malady had attained the margin of the eyes, the face, forehead, and lips, it reached the lower jaw to the root of the neck, the lower half of the outer surface of the auricular concha, the fore-legs as far as the elbows, and the hind ones to the hocks. It produces an acute pruritus, which compels the rabbits to rub against anything near them, and to scratch themselves with their hind-feet. The fur falls off, and white or greyish crusts appear; these are at first thin, but later become more than a centimetre thick, and are very

adherent. When they are removed, the skin is red and bleeding, and on their lower surface are found the Sarcoptes, which are imbedded in them like the *Sarcoptes mutans* of the scabies of the feet of birds.

According to Huzard, this disease is very contagious. It arrests the growth of young Rabbits, sometimes renders the prehension of food impossible, and may result in fatal marasmus.

Diagnosis is easy in presence of the Sarcoptes, as these cannot be mistaken for any other of the three non-psoric Acarina which live in the fur of Rabbits; neither can it be mistaken for the favus that sometimes attacks these animals—the tinea favosa, which is not necessarily localized on the head, and which manifests itself by limited, circular, cupped, and thick crusts of a yellowish-grey or sulphur hue, formed by a fungus, which requires a higher magnifying power to distinguish it than is needed to discover the Sarcopt.

Etiology, Contagion.—It is not established that the sarcoptic scabies of the Rabbit may be derived from that of the Rat or Cat, which are both due to the same kind of Sarcopt. Gerlach was certain that the Sarcopt of the Rabbit could neither live nor produce scabies on any of the domesticated animals—not even the Cat—when a large number are deposited on their skin. On the skin of Man they cause a trifling disturbance—scarcely pruriginous—that disappears in two or three days; though Zürn asserts that the Rabbit scabies is transmissible to Man.

Treatment.—Remove the hair over the diseased part, and even beyond it; rub the skin with soft soap, allowing it to remain on for a short time before washing off; repeat this a second time, if need be, and at five hours' interval; apply twice or thrice to all the mangy and adjoining healthy parts the pomade of Helmerich. Five hours after the last dressing wash these parts (Delafond).

G.—**Scabies of the Dromedary and Camel.**

The Dromedary and Camel are very often affected with scabies, and the prophylaxis of this malady occupies an important place in their hygiene.

This is a sarcoptic scabies, the parasite of which was seen in 1827, according to the report of Biett, by an anatomical assistant in the King's Garden, who thought it was a Sarcopt. In 1841, P. Gervais found it on a Dromedary recently sent from Africa to the Museum of Natural History, Paris. The Sarcopt of the Dromedary and Camel belongs to the species *Sarcoptes scabiei*, of which it forms the variety *cameli*—common also to the Llama, Giraffe, and the *Antilope bubalis*.

The scabies of the Dromedary, which the Arabs have doubtless known from time immemorial, has been particularly studied by the veterinarians of the French army of Africa—Flaubert, Gourdon and Naudin, Chevalier, Imbert, and especially Vallon. Haslam and other veterinarians of the English army in India have also given much information with regard to this disease in the Camel.

Symptoms.—The scabies of the Dromedary and Camel is accompanied by a violent pruritus, which keeps the animal in a state of continual agitation, and causes it to rub itself against everything within its reach—trees, ground, its companions, etc. The malady commences where the skin is thin—inside the flanks, and inferior parts of the abdomen; then it invades the trunk, withers, tail, legs, and interdigital region. It is manifested at first by pimples, which attain a centimetre in diameter, and soon become hairless and excoriated by rubbing. Crusts form; the hairs are detached in places and fall in tufts. The skin is thickened, wrinkled, and covered by dark, thick, and very adherent crusts. The disease makes rapid progress; the crusts increase in thickness and extent; the skin is wrinkled, ridged, cracked, and fissured; from ulcerations flows a scanty, but very fœtid discharge, and the animal presents a repulsive appearance.

The rapid progress of the disease, the complications accompanying it, and the living in herds, contribute to give a particular gravity to the prognosis. Isolated cases are easily cured at the commencement, but when the disease has become generalized, recovery from it is doubtful. What justifies the redoubtable reputation that is attached to Camel mange, is the employment of this animal in caravans travelling far from places where the necessary medicaments can be procured.

Etiology, Contagion.—Predisposing causes have been, from the earliest times, more invoked for this scabies than for any other. Debility, physiological misery, and uncleanliness no doubt play an important part. Young and old animals are more often mangy than adults; and it is in the springtime that the malady prevails among Dromedaries, and invades the greater part of the cutaneous surface.

But it is clear that contagion is the efficient cause, favoured by the promiscuousness in which the Camels and Dromedaries employed with caravans live—carrying baggage, food and munitions of war. Vallon states that when a mangy animal is introduced into a healthy troop, fifteen or twenty days afterwards cases of the disease appear among the latter, and soon all are infested.

The scabies of the Camel and Dromedary is transmissible to Man. Louis Franck, Straus-Durckheim, and Hamon have given instances. The best-known case is that which Biett has reported. Six Dromedaries sent from Egypt to the Museum of Natural History (Paris), in 1827, were attacked by scabies, which was communicated to the men who cleaned them.

According to Palgrave, the itch that frequently affects mankind in Arabia appears to be derived from the Camel, on which it is very common. Bérenger-Féraud has observed a psoric disease in Senegal, named *larbisch* by the Oulofs and Toucolors, which is characterized by the presence, on the fingers and other parts of the body, of furrows like those of scabies. The parasite has not yet been seen, but Carpot thinks that it is the Sarcopt of mange of the Dromedary (R. Blanchard).

Treatment.—The development of scabies in the Dromedary, as well as its transmission, can be prevented by keeping the skin always clean, in properly sheltering the animals, in sparing them from long fatigue and privations, and more especially in preventing them from coming in contact with mangy animals.

During treatment, they should have alible nourishment, with exercise every day, and their hygiene should be ameliorated in every way possible.

The treatment is begun by general clipping, if the malady has not yet caused vast depilation. On the shores of the Red Sea, the mangy Camels are often treated by simply bathing them in the sea for half an hour every day, and when they come out of the water an experienced native rubs the skin with a polished stone, while another throws water over the parts that are rubbed—the operation being terminated by thorough washing. The rubbing with the stone has to be carefully carried out, so as not to produce new excoriations or cause the old ones to bleed.

Lotions of sulphurated potash completely failed at Alfort in 1827. In Africa, from time immemorial, tar has been considered a panacea against scabies. The Prophet said: 'For mange of the Camel, tar is the remedy' (Vallon). And when the Dromedary is two years old, the Arabs are in the habit of rubbing it with tar three times a year after clipping, in order to protect it from mange and the attacks of flies. This tar is obtained from the wood of the *Juniperus phœnicea* and *Thuya articulata*. They make a mixture of two parts of tar to one of water, rubbing it on the skin moderately warm, when it appears homogeneous. This tarring requires particular care; for when the mixture is too strong, the animals succumb to a kind of cutaneous asphyxia—instances of which occur every year. Such accidents are averted by employing a mixture of sulphur, tar and soft soap, applied rather warm. The Arabs in Egypt dilute the tar with fish-oil.

H.—Sarcoptic Scabies of the Dog.

Independently of the demodecic scabies, the Dog may have an ordinary scabies—the sarcoptic—due to the *Sarcoptes scabiei*, and an auricular acariasis—chorioptic—caused by the *Chorioptes cynotis* (Hering). The latter will be noticed in the chapter on parasitic affections of the ear.

In practice, the sarcoptic scabies of the Dog is considered a common disease; but many of those who have assiduously sought for the Sarcopt regard it as rare. Fürstenberg and Delafond, in their numerous investigations, have met with it—the first in one instance, the second in two; and Mégnin has only found it in two or three cases among the hundreds of Dogs he examined, and which were considered mangy. Our own researches remained fruitless

until we began to employ the solution of potash to soften the crusts; since then the parasite has not been rare.

Observers—such as Bosc, Gohier, Bonnes, Hertwig and Hering—have for a long time noticed the occurrence of psoric Sarcoptidæ on the Dog; but the descriptions they give are too brief or too incomplete, and it is not at all certain that they had to do with the Sarcoptes. Gerlach has described the Sarcoptes of the Dog and the scabies it determines; but his description of the Sarcopt is, unfortunately, incomplete and inexact in many points.

Gurlt and Fürstenberg found on a mangy Dog a variety of Sarcopt of large dimensions, which might be the same kind met with by Railliet and Cadiot on a Dog affected with crusted mange; the same was also observed by Mégnin on Wolves, which also had this crusted form of scabies—this was the *S. scabiei*, var. *lupi*; and it was also the same as that found by Fürstenberg in the scabies of Man known as *Norwegian itch*—so named from the country in which it is most frequently seen—a variety of the parasite that he designated *S. scabiei crustosæ*. According to Hebra, the Norwegian itch is not due to a particular kind of Sarcopt, as was at first believed, but to the *S. scabiei*, var. *hominis*, of ordinary scabies, from which it only differs in the greater number of the Sarcoptes and the accumulation of their débris. The Sarcopt of ordinary sarcoptic mange of the Dog—which was certainly seen first by Delafond, then by Mégnin, Railliet and Cadiot, etc.—is a little larger than that of Man; it is the *S. scabiei*, var. *canis*.

Symptoms.—Sarcoptic scabies may appear on any part of the body, but it usually begins on the head, muzzle, around the eyes, and on the ears. It then reaches the belly, the under surface of the chest, the sides, root of the tail, legs, etc., and this so rapidly, that at the end of a month the invasion is general.

It first manifests itself by red punctiform spots, resembling Flea-bites, which can only be seen where the skin is thin and not pigmented—as on the abdomen, in the arm-pits and flanks—though rubbing often renders them diffuse. On these surfaces the early red points are soon converted into papules, from the size of a lentil to that of a pea, the summit of which becomes vesiculous, ruptures, and allows much serosity to escape. This effect is most frequently due to the repeated scratchings under the influence of the pruritus, which lead to the production of more or less extensive moist patches. There may also be seen—and particularly on the fine skin of the belly and flanks—vesicles which are being transformed into pustules—a dark point in their centre communicating with the gallery of the Sarcopt. Sometimes the mange remains dry, and is marked by an abundant formation of scurf and by depilations. As a rule, the surfaces first invaded become dry, and are covered by greyish-yellow crusts, which gradually scale off. The depilated and thickened skin becomes ridged, wrinkled, and excoriated; and in cases of generalized scabies the Dog exhales an offensive odour, and presents a repulsive appearance.

The pruritus is always intense, particularly if the patient is kept in a warm place, and after running. The disease induces a grave state of cachexia and marasmus by the insomnia, continual agitation, deprivation of rest, and interference with the cutaneous functions; and death ensues in two or three months if treatment is not adopted.

Diagnosis.—*Follicular* or *demodecic* scabies is often mistaken for sarcoptic scabies, and this confusion entails an erroneous prognosis; for while the first is very difficult to cure, the latter is comparatively easy to get rid of. Follicular scabies commences like sarcoptic scabies, but the surface it affects is dry; in the latter form it is covered with small yellow crusts, and the papules rarely become pustules—while the acne pimples are, on the contrary, an almost constant sign of follicular scabies, which is also less pruriginous and slower in its course. But discovery of the parasite confirms the diagnosis.

Sarcoptic scabies may also be confounded with what has been termed red mange (*rouge* or *rouget*)—a frequent, but non-parasitic, skin affection of young Dogs, which commences beneath the chest and abdomen and inner surface of the limbs, and is characterized by the red colour of the skin, much itching, and the almost total absence of humidity.

Another skin disease is the *roux-vieux*, *dartre sèche*, *rogne* (dry mange), which is frequent on old or fat Dogs, and is located on the back, more especially on the loins, where it is recognised by the erect hairs—which are reddish at their base—and by the induration of the skin, which is thickened, wrinkled and cracked, brownish-red, slightly pruriginous, and from its cracks there may exude a sero-sanguineous fluid that, on drying, forms brown irregular crusts. These different signs, as well as the absence of the parasite, lead to a diagnosis.

The *humid mange* or *tetter* has a varied seat, and consists in more or less depilated, irregular patches, showing numerous small vesicles, the contents of which escape and keep the diseased surface always moist. There is no parasite, and the malady extends slowly.

The *dry* or *scaly eczema*, or *pityriasis*, is very tenacious in old Dogs, and is situated on the head, neck, and back, causing moderate pruritus, and having little tendency to spread; it is also recognised by the abundance of epidermic pellicles that cover the diseased surface.

Lastly, *trombidian acariasis*, due to the hexapod larva of the *Trombidium holosericeum*, has its principal seat around the eyes, and on the paws and belly. A careful examination will discover the parasite, and thus eliminate scabies from the diagnosis.

Etiology, Contagion.—Youth, debility, or a sickly condition may be considered as predisposing, but not necessary causes; for the Sarcoptes will live on animals of all ages and in all conditions. The existence of follicular scabies also predisposes to the invasion of sarcoptic scabies; but it is evident that contagion is the essential

cause. The admitted rarity of this malady has led to the supposition that Dogs suffering from it have been in contact with itchy people, or have contracted it while hunting animals (Wolf, Wild Boar) affected with psora. But it has been seen in an epizoötic form; for in Germany, in 1890, it attacked 10 per cent. of the Dogs, especially in such cities as Berlin, Munich, Stuttgart, and Cologne. 'During the year 1886-87, of 8,399 animals attending the canine clinic of the Berlin school, 639 were affected with sarcoptic mange. The asylums for Dogs contributed largely to its dissemination' (Friedberger and Fröhner).

Facts of contagion from Dog to Dog—to-day a matter of current observation—have been published by Rayer, Littré, Leblanc, Sabatier, and have been well established by Delafond, who also observed that the sarcoptic scabies of the Cat may be transmitted to the Dog, although due to the *Sarcoptes minor*, and not to the *Sarcoptes scabiei*. He deposited on the skin of a bitch in perfect health 125 Sarcoptes taken from a mangy Cat; and in about a month she was covered with a generalized scabies. In another experiment, four mangy kittens were put to a bitch, which suckled them along with three puppies that she was already nursing. She became mangy, as well as her own progeny, which died of the disease in about two months.

Delafond did not succeed in developing mange of the Dog by Sarcoptes taken from psoric people. On the contrary, however, numerous examples show that Dog scabies can be transmitted to Man.

Chabert says that Dog mange is communicated to Man in a very obstinate form. Grognier has seen a student whose hands were covered with itch after having rubbed a mangy Dog. Viborg gives an instance of a Man and Woman who became psoric from a Dog they possessed. Mouronval furnishes a similar instance. Chavassieu d'Audebert assures us that the Dog and Cat may transmit a very troublesome itch to Man. Biett has seen a child which became infected through caressing a mangy Dog. Hertwig, Heckmeyer, Stütz, and Marrel have published observations of the same kind. Delafond saw a student contract the itch on attending a diseased Dog; and he himself became infected by depositing the Sarcoptes of the Dog on his skin, the itch resulting continuing for about forty-five days, and only ceasing on the adoption of antipsoric treatment. The same experimental result was produced on a student; on two others there was only a fugaceous eruption. Lastly, Gerlach was likewise able to transmit the mange of the Dog to Man, and states that he on two occasions witnessed spontaneous transmission. More recently, Friedberger has seen such transmission from Dogs to women and children; in the latter there was a very pruriginous eruption between the fingers, and on the arms and abdomen. Leonhard reports an analogous case. We have also known of another; and in the epizoöty that occurred in Germany in 1890, hundreds of people who had been in contact with mangy Dogs in Berlin were contaminated. Fröhner in one month reported twenty-one cases of this contagion.

According to Zürn, the Sarcopt of the Dog can be conveyed to the Pig and Horse.

Treatment.—Contagion must be prevented by isolating diseased from healthy dogs, burning litter, washing kennels—the wooden

portions with boiling water kept so in the place to be cleansed, or with creolinated water, 5 to 100—the parts in masonry being lime-washed; in a word, carrying out the various measures already repeatedly indicated.

To combat the debilitating effects of the mange, an abundance of animal and vegetable food—varied and substantial—should be given, combined with tonics. Exercise, and living in the open air as much as possible, should also be allowed.

With regard to medical treatment, the first operation to be carried out is general clipping for long-haired Dogs, no matter how limited the diseased parts may appear. Cleanliness is indispensable. The litter must be frequently renewed, and the patient must be well washed with soft soap and water; a vigorous brushing in the bath at the same time will remove the crusts and diminish the number of parasites. Care must be taken that the animal does not lick off the remedy—especially if it is toxic—by employing a muzzle or a leather covering.

The antipsoric remedies that may be employed are numerous. Friedberger and Fröhner much recommend creolin in the form of a wash, composed of creolin and soft soap, 1 part of each, alcohol ½ to 10 parts, according to the extent and degree of the malady. In generalized scabies, one-third of the body is dressed each day, and a cure is effected in from eight to twenty days.

At the Toulouse Veterinary School, cevadilla oil is usually employed, sometimes cade-oil, or a mixture of equal parts of petroleum and linseed-oil.

Gerlach approved of Peruvian balsam dissolved in alcohol, 1 to 30; its vanilla-like odour renders it suitable for house Dogs. Styrax may be used in the same way. These medicaments give excellent results. Many practitioners employ simple carbolized soap —that is, carbolic acid incorporated with soap in the proportion of 1 to 20.

The pomade of Helmerich—about 100 grammes for a medium-sized Dog—is a simple and frequently-employed remedy. When the Dog has been well dried after its soap bath, it receives a first dressing, which is left on for twenty-four hours. Next day this is washed off with soap and water, and a second dressing is applied. If it has acted well, there is rarely any necessity for applying a third dressing.

Tar cannot be recommended, as it is dangerous to cover all the surface of the skin with it. Ellenberger and Hofmeister have reported a case of fatal poisoning of a Dog which was affected with mange, and had the whole body covered with tar. If this substance is employed, it should be mixed with an equal quantity of soft soap, and alcohol added to give the mixture the consistence of a liniment. The dressing should be extended over three days, only one-third of the body being dressed each day, and a bath given on the fourth day. This series of operations ought to be repeated three or four times.

The oil of lavender and oil of turpentine have often been used for mange of the Dog; but the first is uncertain in its effects, and the second is too irritating, although it forms the most active ingredient in the following application, which is much appreciated by sportsmen and veterinary surgeons:

Sea salt	150 grammes.
Gunpowder	10 ,,
Sulphur	140 ,,
Vinegar	1 litre.

The mixture is made at a boiling temperature, and continually stirred. When it is homogeneous, it is allowed to cool until tepid, and then there is carefully mixed with it:

Oil of turpentine	90 grammes.

This remedy is employed tepid. It causes an irritation of the skin that does not disappear for some days, and it is therefore not to be recommended.

Benzine and creosote are recommended by Gerlach and Zürn, when mixed with oil or alcohol—1 to 30 to 60; but it has been reported that they are too irritating, and even toxic.

Naphthalin, lauded by Fürbringer, Fischer, etc., has been successfully employed by Siedamgrotzky, in the following form:

Naphthalin	15 grammes.
Vaseline	75 ,,
Oil of thyme	āā 8 drops.
Oil of lavender	

The cure is complete in twelve to fourteen days. This is a cheap remedy and soothing to the skin; it acts well when the disease is commencing, and for house Dogs.

I.—Sarcoptic Scabies of the Cat.

The Cat may be affected with a sacroptic scabies, due to the *Sarcoptes minor*, var. *cati*, and a chorioptic acariasis due—like that of the Dog—to the *Ch. cynotis*. (See Parasitic Diseases of the Ear.)

The earliest mention of Scabies of the Cat is due to Wedelius. In 1672, he described an epizoöty which, in two years, and for an extent of some miles, prevailed in Westphalia with such violence that nearly all the Cats perished. Notwithstanding the manifest exaggeration in his account—and particularly with regard to the changes occurring in the eyes—it seems very probable that it was scabies he saw. Girtanner has also published some positive documents on this affection. Rigot, in 1811, reported an outbreak of scabies among Cats which prevailed for nearly four years; and, in 1827, Sajous presented a memoir to the Central Society of Agriculture, on an epizoöty of scabies which had existed for some years, and had killed all the Cats in entire villages. Analogous observations, of which mention will be made hereafter, have also been published; and altogether they prove that the malady has been known for a long time.

If Gohier was the first writer who speaks of having seen the Sarcopt of the Cat in 1813, Hering has given the first description of it; but he only saw the male, and is inexact in several details.

The Sarcopt is now well known, owing to the works of Rayer, Gerlach, Fürstenberg, and Delafond and Bourguignon. The latter considered it to be a distinct species, and named it the 'Sarcopte notoëdre,' a designation given because of the dorsal position of the anus. Fürstenberg named it the *Sarcoptes minor*, and in this species it forms the variety *cati*.

Symptoms.—Scabies of the Cat usually commences on the neck, reaches the ears and forehead, then all the head, and rarely goes beyond the anterior part of the neck. A pruritus of variable intensity is one of the early symptoms.

The *initial lesion is a vesicle or papule the size of a pin's head*; this is promptly ruptured and transformed into a crust. The multiplication of the vesicles, and their replacement by crusts, brings about the invasion of larger surfaces, which are covered by greyish, hard crusts that agglutinate the hairs, the greater portion of which are rapidly shed. The skin becomes thickened, hard and wrinkled; the eyelids are inverted, the eyes are buried in their orbits, and there is more or less intense conjunctivitis. The swollen tissues obstruct the nostrils, embarrassing the respiration; the animal is feeble and languishing, has a melancholy and repulsive physiognomy, and finally succumbs to the disease, if it is not opportunely sacrificed. Death usually ensues in four to six months, though it is earlier in young animals, or when the malady is epizoötic.

According to Mégnin, the dwarf Sarcopt does not excavate a subcutaneous gallery like the common Sarcopt, but makes a simple nest that appears as a miliary eminence; this, when raised on the point of a scalpel, is found to be composed of a layer of epidermis surrounding ova in all stages of incubation, as well as an ovigerous female and her excrements, in the form of brown, cylindrical corpuscles. The larvæ, nymphæ and males wander in the midst of the crusts.

Diagnosis.—The diagnosis of this disease is not difficult. Its commencement on the head and persistency in that region, its rare extension to other parts, the ready discovery of the Sarcoptes, and the special characters of this psora, suffice to remove any doubts as to its nature. It should not be mistaken for a non-parasitic, very tenacious prurigo that sometimes attacks emasculated Cats, and is located on the belly, flanks, back, legs and tail—rarely the head; it consists of small, dry papules, and is very pruriginous and obstinate.

An analogous, but ephemeral eruption is at times seen on nursing Cats which are suddenly deprived of their young.

It is not possible to mistake this scabies for the prurigo of the 'rouget,' due to the larvæ of the *Trombidium holosericeum*, nor with the punctures of Fleas, or the skin affections of old house Cats, which affections have not an invariable localization, and consist of pustular surfaces with thick isolated crusts, and a moderate degree of itching.

Lastly, favus is recognised by the form of its parasitic cup-

shaped crusts, which are usually sulphur-coloured, and by the presence of the fungus.

Prognosis.—Scabies of the Cat is only serious when it is chronic, and when the animals affected have habits of independence which prevent their being submitted to regular treatment; then it follows its natural course and terminates in death. It is more especially serious when it assumes an epizoötic form, and when its gravity cannot be ascribed to any plausible cause. When it is taken at the commencement it is easily cured. Its serious character is increased by the fact of its contagiousness for Man and the domesticated animals.

Etiology, Contagion.—Of 45 scabied Cats, Delafond found 26 aged from 4 to 7 years, 15 from 2 to 3 years, and 5 of six months to a year. The largest proportion of Cats being aged, is probably due to the circumstance that they are less attractive and useful than young ones, and are therefore often driven from their homes and exposed to misery and uncleanliness—that is, to all the predisposing conditions of psoric affections. Delwart mentions having seen the disease in large farms, where many Cats are kept, communicated with such rapidity that in four or five weeks all these animals had perished. Although the dwarf Sarcopt also causes scabies in Rats, it is not established that it is in hunting these that the Cat contracts the malady.

Delafond has succeeded in developing scabies on a Cat, by depositing on it Sarcoptes from a Lion, and on another by cohabitation with a mangy Dog; but these two Cats recovered spontaneously, for their scabies remained artificial, being due to the *Sarcoptes scabiei*, and not to the *S. minor*.

Scabies of the Cat may be transmitted to Man. Hertwig relates the case of a servant who contracted the disease through allowing a mangy Cat to lie in her bed. Berthold cites that of a child who was infected by a diseased Cat, which she permitted to rest on her breast. Marrel mentions having seen Cat scabies transmitted to two adult people and a child. Hering has observed the malady transferred from the Cat to the back, chest and arms of two young people. Gerlach has experimentally effected the transmission of the disease, by depositing some crusts taken from Cats on the arms of students; a local scabies followed, that disappeared spontaneously in about ten days in the first, fifteen days in the second, and three weeks in the fourth student; but in a blonde and very hairy student it continued for six weeks, and at the end of that time terminated only after a sulphur bath had been administered. Perroncito reports a case of contagion from a Cat to a woman, and we have knowledge of a similar fact.

Scabies of the Cat may also be transmitted to the Horse. Hertwig cites the case of a Cat which gave its mange to a Horse on whose back it was accustomed to rest; and Mégnin developed an extensive outbreak on a Horse, by fixing on its withers a piece of skin from a mangy Cat; the disease was cured by a single rubbing with Hel-

merich's pomade. On another occasion he has seen a mangy Cat convey its disease to two Horses, on whose backs it usually lay.

With regard to the Ox, we have already related the case of Rademacher, in which a mangy Cat was in the habit of lying on the back of a Cow and transmitted the disease to it; from this it passed on to a servant and to all the family. We have also mentioned how Delafond succeeded in transmitting the Scabies of the Cat to the Dog.

Treatment.—The treatment of Cat scabies cannot include baths, in view of the repugnance of this species to water, and the danger of affections of the air-passages to which these animals would be exposed by bathing them. So at most, after carefully clipping away the hair from the diseased parts, these can only be washed with soap and water; but it would be even better to dispense with this, and have direct recourse to topical acaricides, which may be repeated.

The pomade of Helmerich is particularly convenient and successful. 'If the balsam of Peru is more efficacious, it is also more dangerous. We have several times seen a single rubbing on the head with this substance produce a very acute cerebral excitement, followed by torpor, and even by death. We have also witnessed the same accidents arise from the application of rancid cod-liver oil, which is recommended by Schwarz. Styrax appears to be less dangerous' (Friedberger and Fröhner).

In the epizoötic outbreak in the environs of Offenbourg, Bell successfully employed a lotion composed of chloride of zinc and water—4 to 500.

J.—Sarcoptic Scabies of the Ferret.

Independently of a Listrophorus which lives in the fur without causing the slightest injury, the Ferret may be attacked by two species of psoric Acarina: a Sarcopt—*Sarc. scabiei*, var. *hydrochœri*, and a Choriopt—*Ch. cynotis*. We shall only notice sarcoptic scabies here, as the auricular acariasis will be described with the parasitic affections of the ear.

Sarcoptic scabies was described for the first time, in 1860, by F. Peuch, who pronounced it to be due to a Sarcopt, and his remarks were confirmed by Mégnin.

The disease is chiefly confined to the head and feet, but it may invade all the trunk. The affected parts are covered with brown or yellow crusts, beneath which the Sarcoptes are concealed; they are the seat of an almost continual pruritus, the little animal frequently biting itself, and especially the feet, in a kind of fury. When the malady is not much advanced, and not localized on the limbs or ears, the body is moist from a gelatinous, almost viscid, sweat that strongly exhales the odour of the ferret.

On the feet, the crusts are attached to the plantar surface and the root of the claws, which may grow to an extreme length, and straighten out or bend upwards. Progression is then slow and difficult, the weight being thrown on the posterior part of the foot.

It is scarcely admissible that the Ferret contracts the disease in Rabbit-warrens, the sarcoptic scabies of these creatures being due to the *Sarcoptes minor*, and not to the *S. scabiei*. It is more likely, as Railliet remarks, that

the origin of the malady is scabied pole-cats, which are frequent in Rabbit-warrens.

Peuch could not succeed in transmitting the Ferret scabies to the Dog, nor yet to Man. But his experiments were so few that they do not justify a definite conclusion.

The disease sometimes appears in an epizoötic form.

Its treatment is reduced to the following prescriptions : 'Frequent dressing of the crusts with glycerin, so as to soften them and render their removal easy ; then vigorous rubbing with simple sulphur ointment, or Helmerich's pomade, on the parts freed from crusts. Frequent and complete removal of the litter, and disinfection or, better, change of residence in box, chest, or barrel' (Peuch).

2.—DEMODECIC SCABIES.

This form of scabies is produced by a parasite—*Demodex folliculorum* (Owen)—of the family of Demodecidæ (p. 85). The acarina *live in the hair-follicles and sebaceous glands of several species of* mammalia.

History.—In 1842, G. Simon, of Berlin, in examining the contents of pustules of *Acnea sebacea* of Man, recognised in the fatty matter expressed by squeezing, in the form of small masses with their external extremity dark—Comedones—the presence of animalcules, of which he gave a remarkable description. By the advice of the learned entomologist, Erichson, he considered them to be Acari, and named them *Acarus folliculorum.* He made known his discovery to the Berlin Society of Naturalists, when Professor Henle, of Zurich, informed him that in the preceding autumn he had observed the same parasite in the hair-follicles of the external auditory canal—so that the discovery was made almost simultaneously ; though Henle appeared to entertain doubts as to the nature of what he had seen. From that time a number of observers sought for, and found, the new parasite. Owen was the first to name it the *Demodex folliculorum* ; but Miescher called it *Macrogaster platypus* ; Erasmus Wilson, *Entozoon folliculorum*, then *Steatozoon* ; and Paul Gervais, *Simonea folliculorum*. The latter designation — Frenchified into *Simonée*, *Simonide* — has often been employed in France. The natural history of the Demodex has been well established by the labours of Wedl, Gruby, Leydig, Küchenmeister, Barensprung, Valentin, Von Siebold, Remak, Mégnin, etc.

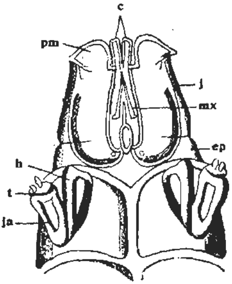

Fig. 86.—Anterior extremity of the *Demodex folliculorum* of the Dog, highly magnified.

c, chelicerae ; *mx*, maxillæ ; *p*, maxillary palps ; *j*, cheeks ; *ep*, epistoma ; *ja*, leg ; *t*, tarsus.

Shortly after the discovery of the Demodex of Man, Topping found that of the Dog, of which Tulk gave a description on December 20, 1843, to the Microscopical Society of London. The disease to which it gives rise was afterwards the object of numerous investigations ; it is, in fact, on the Dog that the dermatosis caused by the Demodex has been most frequently studied.

Description.—The rostrum, which is a little narrower than the thorax, is salient in front, covered at its base by the epistoma, which is itself prolonged

by two cheeks united on the middle line, and advanced to near the anterior extremity of the rostrum. The latter comprises: 1. A pair of cheliceræ, or mandibles, in the form of flattened and lamellar stylets, larger behind—where they are joined on the middle line—than in front, where they are a little divergent; they are related, above, to the epistoma and cheeks. 2. A pair of maxillæ or jaws, separated at their base, lying together in front, where they are continued by the maxillary palpi obscurely articulated. 3. A narrow tongue situated between the maxillæ and their upper surface, and completing the floor of the mouth.

The cephalothorax is convex superiorly, and finely striated in various directions; it is flat on its lower surface, where it shows the four pairs of legs salient on the sides. Each leg is composed of three parts or articles: the haunch, basilar, antero-posterior, triangular, summit posterior, nearly at a tangent outwardly to the margin of the thorax; the leg of the same length as the haunch, and forming with it an angle open in front; the tarsus, a discoid piece crowning the extremity of the leg, and furnished with two claws. These legs rest by the base of their haunch on the transverse arched epimeres, united by a middle longitudinal piece—the sternum.

The abdomen is elongated and conical, striated transversely, and shows at the anterior portion of its ventral face a longitudinal slit, which is the anus. This slit is larger in the female than the male, and probably serves for copulation and ovulation. The males have the abdomen less developed than the females, and possess a genital armature situated immediately in front of the anus.

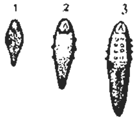

FIG. 87.—Evolution of the *Demodex folliculorum* of the Dog; magnified one hundred diameters.—Railliet.

1, ovum; 2, larval hexapod; 3, larval octopod.

The length of the female Demodex does not exceed 400 μ in the largest varieties; that of the males is not less than 220 μ; while the width at the thorax varies between 40 μ and 55 μ.

The Demodex is oviparous. The eggs are 60 μ to 90 μ long, and 20 μ to 50 μ broad, and are cordiform or fusiform in shape. From the egg issues a larval hexapod, the legs of which are only represented by three pairs of tubercles, while the buccal organs are yet in a rudimentary condition. After a moulting, the larva becomes an octopod, the fourth pair of legs being still tubercles, like the three other pairs. A second moulting transforms this larval octopod into a nympha, which possesses the legs and buccal organs of the perfect state, from which it only differs in the absence of sexual organs in the male, the acquisition of these being the result of a last transformation.

The Demodex has been found on Man, and the Dog, Cat, Goat, Pig, Sheep, Ox, Horse, Aristotelian Deer (Prietsch), Fox (Gros), Rat (Hahn), Field-Mouse (Zschokke), and the Surinam Bat (Leydig). In general, the difference in habitat of the parasite coincides with differences in its dimensions, and these at least authorize the distinction of varieties. We have to mention:

1. DEMODEX OF MAN (*D. folliculorum*, var. *hominis*).—The female measures 380 μ long and 45 μ wide at the thorax; the male is 300 μ long and 40 μ wide. The rostrum is a little longer than it is broad. The length of the rostrum and cephalothorax combined forms nearly one-third the total length of the body. The ova are cordiform or fusiform, from 60 μ to 80 μ long, and 40 μ to 50 μ broad.

The Demodex of Man lives in the sebaceous glands of the face, where it often remains without its presence causing the slightest trouble. When there are more than a dozen in a follicle, this

becomes dilated and prominent, and forms a comedo. It is rare that acne of the face can be attributed to it. Gruby assures us that forty people out of sixty are infested with it; but this proportion has generally appeared to be exaggerated.

2. DEMODEX OF THE DOG (*D. folliculorum*, var. *canis*; *D. caninus* Tulk).—The female measures 250 μ to 300 μ long, and 45 μ broad; the male 220 μ to 250 μ long, and the same width. The rostrum is nearly as long as it is broad; and its length and that of the cephalothorax combined is a little less than half the total length. The ova are fusiform, and from 70 μ to 90 μ long, and 25 μ broad.

This Demodex causes follicular mange in the Dog.

FIG. 88.—*Demodex folliculorum*, male, of the Dog; magnified one hundred diameters.—Railliet.

3. DEMODEX OF THE CAT (D. *folliculorum*, var. *cati*).—*Similar to that of the Dog, but one-fourth smaller in all its* dimensions.

It was found by Leydig, in 1859, on the nose of a Cat affected with Sarcoptic scabies; and by Mégnin in the external auditory canal of two Cats. It appears to be inoffensive.

4. DEMODEX OF THE GOAT (*D. folliculorum*, var. *capræ*).—The female is 230 μ to 250 μ long, and 60 μ to 65 μ broad; while the male is 220 μ to 230 μ long, and 50 μ to 55 μ broad. The rostrum and cephalothorax combined are nearly equal to half the total length. The ova are ellipsoid, and from 68 μ to 80 μ long, and 32 μ to 45 μ broad.

It has been found by Niederhœusern, Railliet and Nocard, and causes a pustular dermatosis which will be referred to hereafter.

5. DEMODEX OF THE PIG (*D. folliculorum*, var. *suis*; *D. phylloides* Csokor).—The female measures 240 μ to 260 μ long, and 60 μ to 66 μ broad; and the male 220 μ long, and 50 μ to 57 μ broad. The rostrum is very developed, and a little longer than it is wide; its length with that of the cephalothorax is nearly equal to that of the abdomen. The eggs are ovoid, and a little contracted and elongated at the ends; they are from 100 μ to 110 μ long and 30 μ wide (Fig. 91).

This form determines a pustular affection in the Pig.

6. DEMODEX OF THE SHEEP (*D. folliculorum*, var. *ovis*).—Found by Oschatz in the Meibomian glands of the Sheep; it differs from that of Man chiefly by the greater breadth of its rostrum and cephalothorax. It has not been seen since Oschatz found it.

7. DEMODEX OF THE OX (*D. folliculorum*, var. *bovis*).—The average length is 200 μ. The rostrum and cephalothorax form about two-fifths of the total length. Eggs ovoid in shape. Causes a pustular affection in the Ox.

8. DEMODEX OF THE HORSE (*D. folliculorum*, var. *equi*).—Found by E. Wilson in the secretion of the Meibomian glands of a Horse. He described it as identical with the Demodex of Man. In 1845, Gros also indicated the presence of the Demodex in the muzzle of the Horse.

A.—Demodecic Scabies of the Dog.

Synonyms.—*Follicular Mange, Red Mange, Black Mange* of the older veterinarians.

History.—As has been stated, the parasitic nature of this disease was first recognised by Topping; and Röll separated the affection from the other exanthemata of the Dog. Delafond and Bourguignon pointed out its gravity, and described it under the name of *Acne Simonea*. Verheyen proposed for it the designation of *follicular mange*, by which name it is now almost exclusively known. It has been more especially studied by Gruby, Haubner, Gerlach, Sparks, Simonds, Oreste, Weiss, Friedberger, Lafosse, Saint-Cyr, Cornevin, Pennetier, Mégnin, Laulanié, etc.

Symptoms.—Follicular scabies presents itself under different aspects, according to its duration; and to such an extent, that one might imagine them to be different diseases, if not informed as to this polymorphism.

At the commencement, there are merely somewhat red depilations about the elbows, hocks, around the eyes, and at the toes; and in the place of the hairs are seen small papules, with a pityriasic powder covering the parasitic patches.

Gradually these depilations extend, become redder, and reach the inner surface of the paws and the cheeks; the eyelids are swollen, inverted—*entropion*—and their borders are covered with an abundant purulent discharge. The skin of the cheeks is thickened, depilated, wrinkled, and covered with papules and pustules more or less irritated. The pruritus, still intermittent, is more marked.

The disease at last becomes generalized, occupying the entire surface of the body. The skin everywhere presents, in different degrees, the characters that it at first showed on the head. Acne pimples are scattered everywhere—sometimes confluent, sometimes discrete; some yet in the papular stage, others pustular. Among the latter, a great number are dark-blue at their summit, and a sanguinolent serosity can be squeezed from them, in which the Demodex can be found on microscopical examination. The parasites are more numerous in the small pustules with apparently purulent contents than in those which merely yield a kind of cylinder of sebaceous fat on pressure. The number of Acarina is often prodigious, and constitutes the greater portion of the product under observation. More or less abundant crusts are noticed at various points, due to the rupture of the pustules and drying of their contents. At the parts most severely affected the skin is moist and cracked, and in the folds there is a yellow viscid matter; the greater portion is depilated, and the animal exhales a fœtid, sour odour that is absolutely nauseating. When the malady has arrived at this stage, it has produced a profound effect upon the whole organism; the appetite—which was for a long time unimpaired, and even increased—now diminishes, emaciation begins, and this gradually goes on to marasmus.

In certain cases, as Saint-Cyr has shown, the disease is generalized, but it does not cause depilation except at some rather circumscribed points; the pustules are rare, but they are irregularly disseminated everywhere, and the condition might be taken for one of generalized acne. In addition, the whole of the skin is covered with a fine dust, as if the animal had been powdered with maize flour. At the hairless places—which are more or less circular—there is much irritation, a serous exudation, excoriations, and even small sores.

An interesting form is that which Saint-Cyr has named 'the circinated form of follicular mange.' It consists of circular patches from 2 cm. to 6 cm. in diameter, red and inflamed—more particularly towards their slightly salient borders, depilated, and often—but not always—showing chiefly at their periphery small,

red, pustular, acne-like pimples. In enlarging, these patches may join each other, and form others more extensive, with largely festooned borders. Often the centre becomes pale and covered with yellow dust. This circinated form is seen in the early stages, and it may be accompanied by the acneic form; it is not very pruriginous, and the general health does not appear to be affected.

This form is related to that which Friedberger and Fröhner have designated the 'squamous form,' and which they give as of frequent occurrence. It is scarcely indicated by any other sign than shedding of the hairs and the abundance of epidermic pellicles.

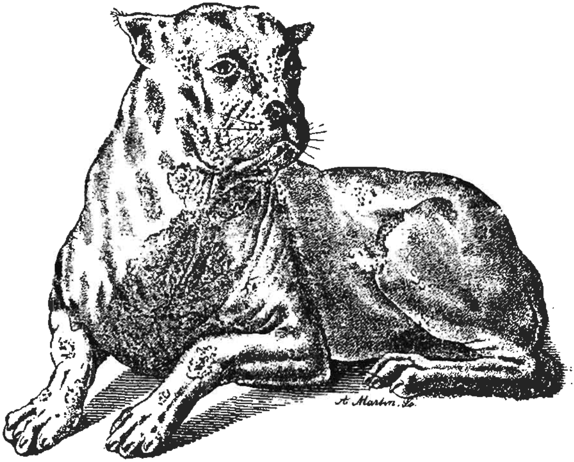

FIG. 89.—A Dog affected with advanced Demodecic Scabies.

There is no humidity, and little, if any, trace of inflammation. The disease commences principally around the eyelids, and the eyes are surrounded by a depilated circle, which is somewhat red and scaly. This scabies may extend all over the body, and is often characterized by the deep tint of the patches, which are sometimes circular, as in the circinated form. There is usually no pruritus, and the diagnosis is difficult—often necessitating a microscopical examination of the sebaceous matter.

Course, Duration, Termination.—Follicular scabies pursues a very slow course, especially at the commencement. It frequently

terminates in death, owing to its resistance to parasiticides. Weiss, however, gives an instance of spontaneous recovery from this scabies of a pregnant bitch which aborted; the pustules gradually disappeared, an abundant desquamation followed, the skin became smooth, and the Demodex could not be found. The animal, nevertheless, succumbed to the cachectic condition into which it had fallen.

Diagnosis, Prognosis.—The circinated form may easily be mistaken for ringworm. However, in follicular scabies the hairs are not altogether absent; while in tinea they are broken close to the skin, which appears as if shaved. The microscope shows on the surface of the epidermis the fungus if the malady be ringworm; but in scabies, scraping the skin to the blood and examining the products obtained will reveal the presence of the *Demodex folliculorum*.

A mistake may also occur with regard to sarcoptic scabies; but the chief points in the diagnosis of this have been already shown, and the microscope must decide in doubtful cases.

The most frequent errors arise with respect to an erythematous skin affection of young Dogs, named *red mange* (*rouge*), which is distinguished from follicular scabies by its being non-parasitic; instead of commencing, like the latter, on the paws and head, it appears on the limbs, on the inner surface of the thighs and forearms, underneath the belly, and on those parts where the skin is fine and almost hairless. It is very pruriginous, and this increases the redness of the skin and induces artificial lesions, as a consequence of the rubbing and scratching.

It must be remembered that demodecic scabies may co-exist with various cutaneous affections of youth, and with sarcoptic scabies and ringworm.

The prognosis of follicular scabies is always very grave, parasiticide treatment rarely succeeding in destroying the Demodex.

Pathological Anatomy.—The prominent feature in the pathological anatomy of this affection is the presence of the *Demodex folliculorum* in the hair-follicles and sebaceous glands; but particularly in the former, where it is seen sometimes in considerable numbers.

Gruby, with Delafond, has counted as many as 200 in one hair-follicle. They are seen to be pressed upon one another, the rostrum being directed towards the bottom of the follicle (Fig. 90), and the ventral surface ordinarily on the side of the hair or the space it should occupy. Here they are observed in all stages of development—from the eggs to the sexualized individuals and fecundated females. By their presence they cause an irritation which is manifested by signs of variable intensity, according to their number and activity. When the inflammation is acute, it extends around the hair-follicle or sebaceous gland, invades the tissue of the derma, and terminates in the formation of pustules. At other times, there is merely hypersecretion of sebaceous matter, which dilates the canal of the follicle.

According to Krulikowski, the parasites, when they have been some time in their first location, pass through its walls into the derma and subcutaneous connective tissue, causing—in the first instance—inflammation of the skin and the eruption of pustules on its surface; and in the second, a small abscess and hæmorrhage. The shedding of the hairs is due to the proliferation of cells on the internal surface of their follicle, and softening of their base. Relapses are brought about by some of these parasites which were encysted, and which have again destroyed the new walls of the hair-follicles.

Etiology, Contagion. — Is follicular scabies due to the presence of the Demodex in the follicles of the skin; or is not the accumulation of these parasites a consequence of the state of irritation existing in the integument? It has been imagined by some persons that the Demodex is present in all Dogs—even those in the best condition—and that there is no disease until their number becomes excessive. Martemucci, accepting these views, regards the affection as a dermatitis situated more particularly in the derma and sebaceous follicles, which—then receiving a larger quantity of blood—have a greater vitality, and can therefore furnish a more abundant nourishment to the pre-existing Demodex; hence their extraordinary multiplication. This authority also proposes to give it the name of *folli-*

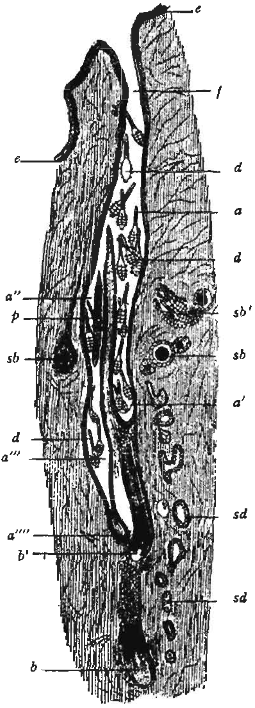

FIG. 90.—Section of the skin of a Dog affected with Follicular Scabies; magnified forty diameters.—After Laulanié.

e, Epidermis continued to form the sheath of the hair-follicle *f*, which—sinuous, and bifid at the bottom—contains two hairs *p*, the bulbs of which are seen at *bb'*. At *a*, *a'*, *a''*, *a'''*, *a''''*, this follicle shows dilatations, due to the accumulation of the Demodex *d*; *sb*, sebaceous glands, one of which, *sb'* contains the Demodex; *sd*, sudoriparous glands.

cular dermatitis, which—in his opinion—is more in accord with its inflammatory character. But these ideas are not well founded. No investigations have been made to establish the constant—or at least very frequent—presence of the Demodex in the skin of Dogs in good condition, as has been observed in Man; and it would seem that Martemucci's notions are only a hazardous generalization of facts appertaining to human dermatology, the only support they receive being the difficulty in transmitting the disease; though this can be explained by the deep, intra-cutaneous habitat of the parasites, and the necessity for a predisposition.

The latter is to be found more especially in the youthfulness of the animals, for it rarely happens that adult creatures are attacked. Breed also plays an important part. L. Lafosse mentions that lap-dogs, before or after having paid their tribute to the disease of youth (distemper), are more frequently affected with follicular mange, although no breed is exempt. The observations of Cornevin are—so far as breed is concerned—more in accord with what is usually remarked, that the disease is more frequent in short-haired than in long-haired Dogs.

Accepting these predisposing causes, the efficient cause is contagion. But this is much less easy to produce than in the other kinds of scabies, owing to the deep situation of the parasite. Delabère-Blaine and Clater—quoted by Verheyen—assert that Dogs which cohabit for a long time with mangy ones, do not contract the malady, and that at other times the slightest contact will suffice to convey it. These differences may be explained by errors in diagnosis, the demodecic cause of follicular scabies not being known when the statements were made. Since that time instances have been reported in which contagion has not been effected, notwithstanding every facility for its taking place. Weiss's patient lived from eight to fifteen days among other Dogs, without these contracting the affection. Rivolta has transferred the Demodex from a diseased to a healthy Dog without result. Martemucci has inoculated the healthy parts of the skin of a Dog with the fluid rich in parasites from pustules on diseased regions, and yet the result was negative. It has been the same with the experiments of Friedberger, who, besides, has not observed contagion occurring by making diseased Dogs associate with those which were healthy; and the observations of Siedamgrotzky, made at the Dresden Veterinary School, and those of Csokor, carried out at the clinic of the Vienna Veterinary School, are to the same effect.

On the other hand, Haubner has succeeded in producing the disease by depositing demodecic pus directly on the skin of a healthy Dog; for at the point where he placed the animalcules, in about twenty-four hours there was slight tumefaction of the skin; in forty-eight hours the follicles already contained a purulent fluid, in which young and adult acari, as well as ova, could be distinguished by means of the microscope. The exanthem extended, but the Demodex disappeared, and a spontaneous recovery took place.

Cornevin made four inoculation experiments, and succeeded in one; but here, also, in about eight days the malady vanished of itself. This authority mentions a somewhat striking instance of contagion from a nursing bitch to two of her puppies; a third puppy remained free from the disease. Of four Dogs—three of which were adults and the other smooth-haired, five months old—inoculated by Guinard, only one, the last-mentioned, contracted the disease.

In fine, experiments and clinical observations demonstrate that the transmission of follicular scabies from Dog to Dog is very difficult.

Martemucci and Friedberger have in vain attempted to pass the Demodex of Man to the Dog.

With regard to transmission of the follicular scabies of the Dog to Man, this has only been reported by Zürn, who has seen a veterinary surgeon, a coachman, and a woman, who attended on Dogs so affected, suffer from a very pruriginous eruption on the hands and feet, the pustules which formed containing the Demodex. But these persons must have had a marked predisposition for the malady; as for years, and daily, persons have attended, and now attend, upon diseased Dogs without taking any precautions, and yet no cases of contagion are recorded. And Martemucci has unsuccessfully inoculated demodecic pus from a Dog on Man; while Cornevin has failed to implant the disease on himself.

Treatment.—Every known parasiticide substance has been tried for the cure of follicular scabies of the Dog, but generally in vain; as the parasites are deeply situated, and beyond the reach of the remedies employed. There is no need to enumerate all the attempts which have been made to combat the malady; so we shall only indicate those which sometimes have had a good result.

Balsam of Peru has been particularly recommended by Siedamgrotzky. It has been used diluted with four parts of alcohol, and rubbed into the skin every day, after the pustules have been squeezed, so as to remove their contents. By this means he says he has obtained a cure in a case of generalized scabies. Zundel also states that he has derived excellent results from this medicament, though it was more diluted. But the treatment is very expensive, owing to the long time it has to be continued and the care required; for in simple cases, Friedberger and Fröhner have only been able to effect a cure after fifty-eight days' rubbings. On one occasion, after sixteen weeks' treatment of a Dog that was seriously affected, it was supposed to be cured; but the disease soon reappeared when the remedy ceased to be applied.

Brusasco's method consists in the employment of *sulphuret of potash* and *cantharides ointment*. Friedberger and Fröhner assert that they have completely cured very advanced cases. The Dog being clipped, a sulphur bath is administered, 500 grammes liver of sulphur (calcium sulphide) to 100 litres of water. Then, for three days in succession, one-third of the body is dressed with an ointment

composed of cantharides ointment 1 part, lard 6 parts. On the fifth or sixth day, the entire body is washed, and a few days afterwards the sulphur bath is again given, followed by the ointment as before, and so on until a cure is effected. But such a result is far from being constant; for Friedberger and Fröhner have failed in one case, after sixty-eight days' treatment, during which 12 sulphur baths were administered, and 9 total applications of the ointment, plus 9 partial applications. In any case, there is reason to apprehend dangerous irritation of the eyes; so that it is advisable to employ the balsam of Peru for the parts surrounding them.

Creolin should be tried. In strong solution—30 to 100—Reul has had a cure in a case of partial disease; and the results of the trials of Guinard, with an ointment composed of creolin 5 parts and lanolin 100 parts, are encouraging. But it must be noted that this treatment has not been successful in the hands of Watkins.

Unterberger has succeeded with the *essence of juniper* applied with friction; four applications were sufficient. Weiss recommends the same remedy. W. Hunting advises: creosote, 16 grammes; olive-oil, 300 grammes; solution of potash, 30 grammes. Mix the creosote and oil, then add the caustic potash. One or two applications a week are to be made, according to the chronicity of the disease, and the treatment continued for several months.

Saint-Cyr has recommended *corrosive sublimate*, and Cornevin has employed it in the form of bath, 1 or 2 grammes to the litre of water. But mercurial intoxication is frequent, either from the animal drinking some of the fluid or licking itself, or the poison is absorbed through the skin. The duration of the bath, which is at first for three-quarters of an hour, is gradually reduced to half an hour.

In simple cases, Zürn says he has sometimes succeeded with *benzine* ointment—1 to 4 of lard; and he quotes Hofer as being also successful with an ointment of carbolic acid—1 to 30; while Vogel advises a solution of *caustic potash*.

Herbet has cured, in fifteen days, a case of follicular mange that had lasted six months, with *Dippel's animal oil* (obtained from bones and horns), applying it in partial frictions, alternately with soft-soap washings.

Mégnin's treatment consists in giving every day—for at least a month—*Barèges baths* of a quarter to half an hour's duration, the skin being kneaded in such a manner that the sulphurous solution may penetrate every part of it. In the second month the bath is only given every second or third day. Mégnin has cured obstinate cases by this treatment, and, of course, all the more easily as the affection is recent. Recently he has recommended the *sulphuret of lime*, prepared by boiling 100 grammes of sublimed sulphur and 200 grammes of quicklime in a litre of water. After cooling, the clear portion is decanted and kept in a well-corked bottle. To use it, it is diluted with four or five times its weight of tepid water, and applied by means of a sponge every day until the disease is cured.

Whatever may be the topical treatment employed, it would be advantageous to combine with it the internal administration of sulphur, in as frequent and large doses as the Dog can bear without injury to health; the sulphur being excreted to some extent by the skin (Fleming).

B.—Demodecic Scabies of the Pig.

This disease was observed for the first time, and well described by J. Csokor, who considered the parasite as a kind special to the Pig, and named it the *Demodex phylloides*. It is the form just described under the designation of *D. folliculorum*, var. *suis*. More recently we have met with it in some portions of the skin of a Pig received from Barcelona. It has since been seen by Wright and Lindqvist.

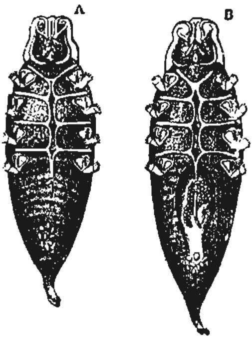

FIG. 91.—Demodex of the Pig, seen on the ventral surface; magnified 250 diameters.—Csokor.

A, male; B, female, with an ovum visible in the abdomen.

The disease greatly resembles the follicular scabies of the Dog, and appears as pustules of variable size, the largest usually resulting from the confluence of the smallest. They may or may not be pigmented, are more often deep than superficial, and may be surrounded by an inflammatory zone. The pustules gradually increase in size, and, in rupturing, leave large ulcers. They occupy more especially the finer parts of the skin—the snout, neck, underpart of the chest and abdomen, flanks, and inner surface of the thighs. The top of the head, back, and external surface of the limbs remain free from the disease. In the smaller pustules, Csokor has found 50 to 60 parasites; while others contained 500 to 1,000. They were mixed up in the inflammatory products, pus corpuscles, and fat in the form of granules and drops. They were lodged, and appeared to multiply, not in the hair follicles, but in the sebaceous glands.

The malady ought to be contagious, for in the instance recorded by Csokor it was observed in 22 Pigs forming a single drove belonging to one owner. But Lindqvist, of Stockholm, has only seen one animal affected in a lot of 800 Pigs.

The disease should not prevent the flesh being consumed as food.

C.—Demodecic Scabies of the Goat.

This was observed for the first time by Von Niederhœusern, at the Veterinary School of Berne, Switzerland. A Goat showed on different parts of its body, but especially about the middle of the trunk, nodosities the size of a pea to that of a nut. They were hard, and it was only by strong pressure that a semi-solid, yellowish grey matter could be extruded from them; this was almost entirely composed of the Demodex. But all the parasites were in the form of larvæ, similar to those of the Demodex of the Dog.

In May, 1885, Nocard and Railliet 'found the same parasite on a two-years-old Goat, born and bred at the Alfort School. The Demodex were in abundance in a kind of pustules of variable size, occupying especially the sides and flanks; and the parasites were imbedded in a considerable mass of cerumen.'

D.—Demodecic Scabies of the Ox.

The Demodex, already noted by Gros (1845), in the muzzle of the horse, was found by W. Faxon, in 1878, in the hides of cattle prepared for tanning, and sent from Illinois and Minnesota to Boston. More especially in the region of the neck and the shoulders, these skins showed numerous pustules formed by dilated hair-follicles; they were filled with a soft, whitish matter, which escaped by pressure, and was composed of fat globules and a multitude of the Demodex. After being tanned, the skins exhibited small cavities, many of them extending through the substance of the hide.

A case of the disease was observed by Grimm in a fifteen months' old heifer, badly developed and in poor condition, notwithstanding good food. With the exception of the head and limbs, the skin elsewhere—especially at the shoulders—was studded with nodules the size of a pea. The surface of these small tumours was hairless and smooth, and when squeezed yielded a thick, viscid pus containing an enormous quantity of the Demodex. The other animals in the herd were quite healthy in every respect.

B.—ACARIASES OF DOMESTICATED BIRDS.

Birds are for the Acarina, as they are for the Pediculinæ, hosts of predilection. There is scarcely an individual on which a variable number of Acarina cannot be found, the majority of which can be supported with indifference; for, living on the matters composing the feathers, they do not affect the health of their host. They belong to one or another of the following four families: *Ixodidæ*, *Gamasidæ*, *Trombidiidæ*, and *Sarcoptidæ*.

As for the Mammalia, we distinguish *non-psoric* and *psoric acariases*; the first are caused by the non-psoric Ixodidæ, Gamasidæ, Trombidiidæ, and Sarcoptidæ; the others exclusively by the Sarcoptinæ.

ARTICLE I.—**Non-Psoric Acariases.**

I. **Ixodidæ.**—The Ticks found on domesticated birds are: *Argas reflexus*, *A. miniatus*, *A. persicus*, and *Ornithodoros tholozani*. The *reflexus* or bordered Argas infests pigeons, the Persian Argas attacks Poultry and sometimes Man, and the *Miniatus*, or chicken tick, infests poultry, particularly in the Southern United States, where it has also been found on Cattle.

Argas Reflexus (*A. reflexus* Fabr.).—Rostrum similar in both sexes and 1·9 mm. long, the dart being 1 mm. long, and having on its inferior surface two rows of teeth on each side, with the commencement of a third row near the point, which is rounded; the chelicerae are terminated by a three-toothed harpoon. The four pieces of the palps are cylindrical and somewhat hairy. There are no eyes. The fecundated and replete female—one-fourth larger than when fasting—measures 6 mm. long and 4 mm. broad. The body is ovoid, and somewhat broader behind than before. The central portion is of a dark hue, and corresponds to the digestive apparatus, which sends its digitations towards the periphery. The vulva is situated at the base of the rostrum, between the first pair of legs. The *male*—uniformly brown, and a little smaller than the fasting female—has its sexual orifice at the third pair of legs. The *nympha*—of the same size as the male—is distinguished by the absence of the genital pore. The *larva*, hexapod, has the rostrum terminal. Eggs ovoid and reddish in colour.

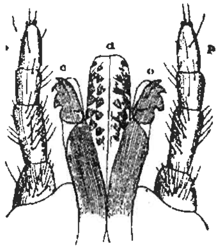

FIG. 92.—Rostrum of the *Argas reflexus*, seen from above; magnified fifty diameters.—Railliet.

c, Chelicerae; *p*, maxillary palps; *d*, maxillo-labial dart, the teeth on the lower surface being seen through the transparent organ.

This Argas lives in dove-cots, and sometimes in considerable numbers infests the Pigeons and sucks their blood. It is frequent in Italy and some parts of France, but somewhat rare in Germany and England.

This species, of all ages and both sexes, lives on blood, the larvæ even appearing to be fixed for a longer time than the adult on the bodies of the Pigeons. It avoids the light, and during the day—like the bed Bugs—it remains hidden in the interstices of the locality—fissures in boards, holes and cracks in the walls, etc., commencing its mischief at night. When these parasites have invaded a dove-cot, the rearing of pigeons is compromised. They attack by preference the young Birds, which they cause to die from exhaustion in from eight to fifteen days. They are more particularly found on the neck and beneath the breast, but no region of the body is free from their attacks. The exhaustion is due not only to the quantity of blood extracted, but to the restlessness caused by the pricking; sleep is disturbed and interrupted, and the incubation of eggs is irregular, if not altogether suspended.

They are readily propagated from one place to another, availing themselves of every passage and crevice, and particularly of the beams and joists. It is not absolutely rare to find them in hen-roosts situated beneath dove-cots; though they do not annoy Poultry.

What contributes to make them more redoubtable, is their great vitality, and the faculty they possess of reproduction in the absence of everything capable of nourishing them. Successive generations have to content themselves with the organic matters furnished by the place in which they are located. Once satiated, this species can live for a very long time without another repast. Railliet has kept three very emaciated ones in a bottle for four months; and Perron-

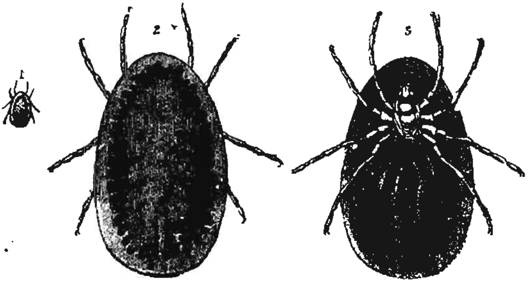

FIG. 93.—*Argas reflexus*, a fecundated and replete Female.—Railliet.
1, natural size; 2, magnified, and seen on the dorsal surface; 3, the same, seen on the ventral surface.

cito mentions that Ghiliani has seen one exist, fasting, for twenty-two months.

The *Argas reflexus* feeds also, on occasion, on the blood of Man. Latreille has found the parasite wandering in houses, and Blanchard states that Mégnin received from Strasburg some specimens that had been gathered from the clothes of a Man. In 1858 and 1859, Boschulte, at Camen, Westphalia, remarked the presence of a large number of the parasites in a bedroom inhabited by children, and communicating with an old pigeon-house. They are only seen in the evening, and as soon as a light appears they remain motionless, giving no sign of life even when they are touched.

Children are bitten during sleep, and chiefly on the feet and hands, the bites being marked by a red point but no areola. There is great itching, rather along the course of the nerves than at the seat of the lesion. On a girl of fourteen or fifteen years old there were real vesicles similar to those produced by burns, and on an

old Man there was a small ulcer. The pruritus sometimes persists for eight days. Chatelin, of Charleville, states that a child and a Man had most painful punctures and persistent œdema, caused by the Argas from a house dove-cot which had been unoccupied for six months.

It is necessary to destroy these parasites by every possible means. When they are seen on the body of a Pigeon, they ought to be removed by gradual traction—so as not to leave the rostrum in the wound—and then crushed.

But, above all, the infested dove-cot should be purified; the walls scraped and whitewashed, chloride of lime being applied to the woodwork, scalding everything with boiling water, and putting petroleum into the crevices. In addition, some insecticide powder should be blown in among the feathers of the Pigeons, as has been already recommended for phthiriasis, taking care to damp the plumage previously with glycerin and water. Lastly, it has been recommended to wash the legs and feet of the Pigeons with an alcoholic solution of the balsam of Peru (Zürn).

II. **Gamasidæ.**—The **Dermanysses** (*Dermanyssus* Dugès) are the only Gamasides which live on Birds; they may also infest Mammals.

They are distinguished from Gamasidæ (p. 85) by their integuments being soft and finely striated throughout, with the exception of two small transparent, lyriform plastrons; and by their chelicerae, which are different in the two sexes—being in the shape of a long thin stylet in the female, and subdidactylous in the male. Oviparous.

The species only interest us by their parasitism on Poultry, and by their possible extension to various Mammals.

Dermanyssus of the Fowl (*Dermanyssus gallinæ* Redi).—Body ovopyriform, posterior end largest, slightly flattened from above to below; abdomen margined by short, well-separated bristles; colour varying from yellowish-white to blood-red, according as the parasite is fasting or more or less full; the intestinal tube, gorged with blood, can be seen as a variously-shaped figure. The ovigerous female is ·70 mm. long and ·40 mm. broad; the male, ·60 mm. and ·32 mm. broad.

A Dermanyssus of Swallows (*D. hirundinis* De Geer), and a *D.* of Birds (*D. avium* De Geer) have been described; but their specific value has not been well established, and many authorities are of opinion that those found on Poultry, Swallows, and house Birds are only varieties of the same species. The Dermanyssus of the Turkey (*D. gallopavonis* Gerv.) is certainly identical with that of the Fowl.

The Dermanysses of the Fowl live in the poultry-yards and dove-cots. Essentially noctambulatory, during the day they are concealed in fissures in the floors, walls, perches, nests, and in all the corners and angles of the locality—the straw nests of the Pigeons being often infested. There are to be found numerous colonies of males and females—free or coupled—with nymphæ and ova. At night they scatter themselves over the Birds within

their reach—Fowls and Pigeons—and by pricking with their keen rostrum, they extract a notable quantity of blood. They readily become hurtful to the chickens and young Pigeons, and produce wasting or death; while their pricking prevents the creatures resting, causes them to become emaciated, and hinders Fowls from hatching steadily.

When the Birds they torment are examined during the day, the parasites are not found, and it rarely happens that there are any traces of their punctures. Sometimes, however, intermittent as are their habits, they become permanent parasites, and may then be found by day, sometimes in great numbers on Fowls, and—more frequently—on Pigeons, running about with great rapidity. They are extremely prolific, multiply very quickly, and—which assures their preservation—they can remain for months without a host capable of satisfying their sanguinary appetite.

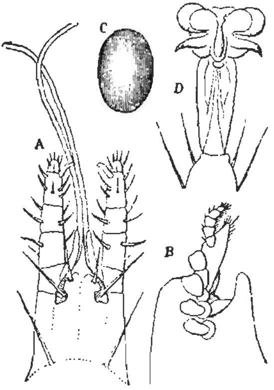

FIG. 94.—*Dermanyssus gallinæ*.

A, rostrum of the female, seen from above; B, seen in profile; C, ovum; D, tarsus.—Delafond.

It is asserted that they sometimes enter the nasal cavities of Birds, and occasion a catarrhal inflammation. Zürn has observed them in young Pigeons, and Weber in Poultry (Zürn); Lax, of Hildesheim, has found them in the external auditory meatus, on making the autopsy of several chickens (Zürn). But these instances are altogether exceptional.

The treatment of dermanyssic acariasis consists in the employment of the parasiticide measures described with respect to phthiriasis—insecticide powders, boiling water, lime-wash, sulphuret of carbon, and creolin are the principal agents to which recourse must be had, according to the indications and modes of employment previously given.

In cases of rhinitis, olive-oil—to which a little ethereal essence of aniseed may be added—should be introduced into the nasal cavities by means of a thin feather.

Transmission to Man.—The Dermanysses are not limited in their attacks to Birds, but may transfer themselves to Man and other Mammals.

So far as the human species is concerned, it is the country people

of the poultry-yards, and the towns-people who handle and pluck the fowls, who are exposed to the incursions of the Dermanysses. They do not produce a true dermatosis, for the parasites do not find conditions favourable to their multiplication on the skin of Man, nor do they become acclimatized there. The disease is rather limited to an ephemeral pruriginous affection, resembling certain forms of the papular eczema of ordinary scabies. It is chiefly observed on the back of the hands, and so much of the fore-arms as

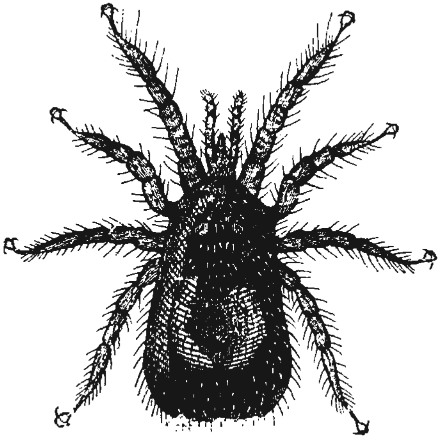

FIG. 95.—*Dermanyssus gallinæ.*
An ovigerous female, seen on the dorsal surface; magnified about eighty diameters.—Delafond.

is uncovered during work; but it may also exist on all exposed parts and even on the body generally.

Alt has found Dermanysses on the neck and arms of an old cachectic woman; they were lodged in small excavations. Bory de Saint-Vincent has described and figured an Acarian that caused great itching on the body of a woman forty years old, on whom the parasites were found in large numbers; as far as can be judged from the figure—which is rather insufficient—it certainly appears to be a Dermanyssus closely related to *D. gallinæ*. F.-V. Raspail states that he has witnessed the action on Man of the Dermanyssus of Pigeons, which he named *Tique*, but which is readily known by the figures he gives. Children and adults were invaded—not only

after having touched the Pigeons, but also in frequenting gardens manured with the dung of these birds. This small calamity disappeared when the Pigeons were removed and the excrement was buried. Goldsmith attended a woman to whom the Dermanyssus was conveyed by Pigeons; the parasite only appeared when she was perspiring, afterwards concealing itself in the cutaneous glands. In a case observed by Geber, the Dermanyssus of the Fowl had caused a diffused eczema on a woman; it lasted four weeks, and then disappeared spontaneously.

The affection generally subsides of itself after the parasites are got rid of, the itching being allayed by some soothing application. According to Fuchs, the best means of getting rid of the Dermanyssus—which may be got by handling Fowls—is to place the person for some time in a haystack.

Transmission to the Domestic Mammalia.—It is to the Horse that the Dermanyssus is most readily transferred, and it may excite a pruriginous affection which has often been mistaken for scabies.

The first mention of transmission of this acariasis to the Horse is as long ago as 1843, and is due to Gurlt. But it was Demilly, in 1846, who clearly defined the affection produced in the Horse by the Dermanyssus. Some years afterwards—in 1850—H. Bouley gave an excellent description of the disease; and since then other observers—Henderson, Caussé, Woodger, Delwart, Moon, and Taylor, etc., have published instances of it. In all the cases, the cutaneous malady of the Horse coincided with the presence of Fowls or Pigeons in the stable or its vicinity; and it ceased—with or without treatment—when the animal was placed in a healthy stable, but only to reappear when it was returned to its former dwelling. It also ceased when the latter was cleared of the Fowls, and was disinfected. It was at first attributed to the Lice of the Pigeons, or Poultry, the parasites found on several occasions on the diseased Horses being recognised as such; for this reason the parasite was named the *Poultry Louse*, and the malady designated *Phthiriasis of Birds*. Reynal and Lanquetin believed they had found the origin of the disorder in the scabies of Poultry, due to the *Sarcoptes mutans;* and some experiments—certainly badly conducted—led them to imagine that this sarcopt, so slow in movement, was capable of developing in a single night all the disturbance that characterizes this dermatosis of the Horse. Mégnin observed that this Sarcopt, when deposited on the Horse, induced some itching, but that it died on the spot where it was placed, without multiplying—it had not become acclimatized. He concluded, therefore, that Poultry scabies was not contagious for the Horse. What rendered the recognition of the part played by the Dermanyssus in the disease was its noctambular habits, which impelled it to fly from the light and conceal itself at the bottom of the hairs. On one occasion, however, at the clinic of the Alfort Veterinary School, there was seen a colony of the parasites in broad daylight, on a light-coloured Horse, the clothing on which had not been removed for a week—hence the parasites were living in obscurity. These Acari, in fact, do not gather in any great numbers on the Horse except during the night; in the daytime they hide themselves in the walls, manger, litter, etc. In consequence of the true cause of the disease, the improper name of phthiriasis given to it should be abandoned, and that of *Dermanyssic Acariasis* adopted.

The malady is sudden in its commencement, and is characterized by general, intense, and continuous pruritus—at least during the night; at the same time, the skin is the seat of an eruption of very small vesicles—some isolated, but the greater number agminated

on a variable extent of surface. The epidermis is removed by the friction, and there is exposed a raw circular patch from 5 mm. to 10 mm. in diameter, which is soon covered with a new layer of epithelium. But usually the Horse is not observed until after this period, when the depilation succeeding the desiccation of the vesicles has commenced. This depilation is, it may be said, pathognomonic—as it gives the skin a flea-bitten aspect, in consequence of the multiplicity of smooth circular surfaces it occasions.

A general invasion of the integument may take place in three or four days, and it might be imagined, from its appearance, that one had to deal with a herpetic malady of much older date. To the lesions caused by the Dermanyssus are to be added excoriations, crusts, ulcerations, etc., consequent on the rubbing.

From confluence of the depilations may result large denuded patches, on which may be seen lenticular spots, which are smoother, because of the desiccation of the vesicles.

If the malady continues for a long time, it may, by the torment it induces, lead the animals to a state of marasmus.

Dermanyssic acariasis is distinguished :

1. From ringworm, in the latter having larger depilations, these being margined by broken, brush-like hairs.

2. From *phthiriasis* due to the *Hæmatopinus macrocephalus*, in that this has only depilations on limited points, and its seat is more especially the root of the mane and tail.

3. From *sarcoptic scabies*, which it most resembles, but which has not its sudden invasion, its rapid generalization, nor its pruritus so continuous ; besides, we inquire whether the malady had its origin in the neighbourhood of Poultry or Pigeons ; and if grooming is suspended and the clothing left on the body, there is a probability of finding the Dermanyssus.

The treatment consists more especially in moving away the habitation of the Birds. Poultry ought to be banished from the stable and its immediate vicinity. The affection will then disappear of itself in a few days, and it may be assisted to do so by some emollient or sulphurous lotion.

Gurlt states that the parasites may also pass to the Rabbit ; Farez has found them on the Goat, and Zürn affirms that Dogs and Cats have a vesicular eruption from their attacks. Möbius has observed a peculiar dermatosis on eight Cows, consisting of rounded depilations which had been unsuccessfully treated for two years, but disappeared when some Swallows' nests had been cleared away from the cowshed; these nests contained the Dermanyssus. Lastly, Gassner, Stadler, and Schümacher have reported cases of auricular acariasis due to the same parasite. (See *Parasites of the Ear*.)

III. **Trombidiidæ.**—Like those of the domesticated Mammals, the Trombidiidæ of Poultry belong to the *Trombidinæ* and the *Cheyletinæ*.

In the *Trombidinæ*, it is the *Harvest-bug*, or *Leptus autumnalis*—the larva of the *Trombidium holosericeum*—observed by Csokor, Eloire, and by Railliet

and Lucet on Fowls and chickens. According to the last two authorities, the presence of the *Leptus* on chickens hatched at the end of summer and during the autumn is somewhat common, and sometimes causes considerable mortality. The parasites fix themselves by their rostrum to the skin at the base of the feathers, and cause such an intense degree of irritation as to give rise to an epileptiform affection that leads to a fatal termination in a few days. Insufflations of flowers of sulphur among the feathers appear to have given good results.

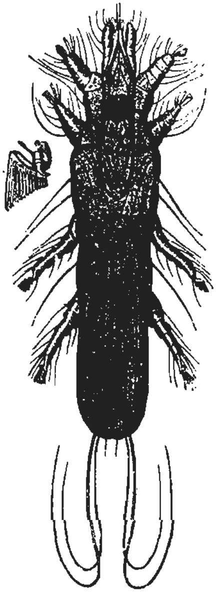

FIG. 96.—*Syringophilus bipectinatus*, female, of the Fowl, seen on the ventral surface; magnified one hundred diameters.

a, tarsus of the fourth pair of legs, seen laterally; magnified 375 diameters.

The *Cheyletinæ* parasites of Birds comprise the genera *Cheyletiella*, *Sarcopterus*, and *Syringophilus*.

The **Ch. heteropalpa** (Mégnin) lives at the base of the feathers of Pigeons and other Columbæ, as well as Sparrows, which do not appear to suffer any inconvenience from its presence. Its body is rhomboidal in shape, elongated from before to behind; the rostrum is conical, narrow, elongated in front, bordered on each side by the palps, which are much smaller than in the *Cheyletiella parasitivorax*, and do not exceed the rostrum in the female, in which the hooklet on the second-last article is small and much bent; in the male, on the contrary, they exceed the rostrum by one-third, and their hooklet is curved. The anterior and posterior legs are almost alike. The length of the male and female is ·35 mm., the breadth of the female being ·25 mm., and the male ·16 mm. (Mégnin).

The **Sarcopterus** (Nitzsch) has, like the Cheyletiella, powerful palps, the third article of which is exceeded by the second; but the latter has at its extremity, not one, but three hooks curved upwards and backwards. 'The **Sarcopterus nidulans** (Nitzsch) lives in numerous colonies in the dilated feather follicles, forming a sort of cutaneous tumour, especially in the Passeres. Mégnin states that he has often found the pubescent nymph wandering amongst the feathers of pigeons and some other birds' (Railliet).

Zürn, who has found the nodules of the Sarcopterus on the Pigeon, says that if these parasites are in small number in the cysts, they may at most disturb, locally, the formation of the feathers; but if they are abundant they bring about deranged nutrition, and then a fatal wasting.

The **Syringophiles** (*Syringophilus* A. Heller) constitute, in the sub-family of the Cheyletinæ, a small degraded group, remarkable for the elongated vermicular shape of the body, the very marked reduction of the palps, and are more particularly characterized by the presence of two yellow chitinous organs like combs, placed at the base of the hooks which terminate the tarsus of each leg.

The Syringophiles are represented in the domestic birds by two species—the *S. bipectinatus* (Heller) and the *S. uncinatus* (Heller).

The **S. bipectinatus** shows very distinctly the two combs on the tarsi. The male measures ·7 mm. and the female ·9 mm. long, and ·14 mm. to ·15 mm. broad. It lives on Poultry, Guinea-fowl, and Pigeons. Heller found it on 90 per cent. of the Fowls he examined at Kiel, but it is much less frequent in France.

The **S. uncinatus** (Heller), met with on the Peacock, is distinguished from the preceding species by its squat shape, smaller combs, and the presence of strong hooklets on the palps.

'The Syringophiles are found within the quills of the wing-feathers and in those of the tail, and often also in those of the wing-coverts. In the affected feathers, the quill has lost its transparency, and instead of regular cones formed inside by the retraction of the pulp—as seen in the normal state—there is only an opaque or powdery matter. If the feather is split, and this matter is examined microscopically, it will be found to consist of living, but almost inert, Syringophiles of all ages, surrounded by the skins they have shed, their dark-coloured excreta, and the débris of the cones they have destroyed by feeding upon them. Isolated individuals are met with accidentally outside the feathers. It is probable that all leave the interior of the feathers in the autumn—when these become dry and are about to be shed—and seek a new habitation in the young plumage' (Trouessart).

According to our own observations, however, it is not uncommon to find only the dead bodies of the parasites in the feathers which are plucked during the winter.

Trouessart admits that they find their way into the feather by its upper umbilicus, which remains widely open during the whole period of development, and is not closed until the quill is fused to the shaft, which springs from it as from a sheath; on the contrary, it is by the inferior umbilicus that they should make their exit, but only after the desiccation and death of the feather in the autumn moulting, when this orifice becomes free. In support of this opinion, Trouessart cites what he has observed in the Sarcoptidæ plumicoles, which also penetrate more or less accidentally into the quills of the feathers. The alteration in the pith of the feather has no influence on the health of the bird.

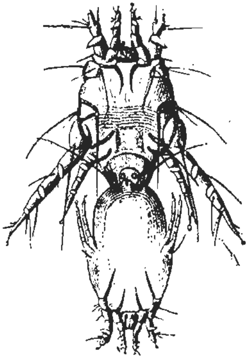

FIG. 97.—*Megninia asternalis*, of the Pigeon.

Male and pubescent female coupled, seen on the ventral surface; magnified one hundred diameters.

IV. **Sarcoptidæ.**—The nonpsoric Sarcoptidæ of Birds belong to three of the six families or tribes into which this family is divided (see p. 103). These are the *Sarcoptidæ plumicoles* or *Analgesinæ*, the *Sarcoptidæ epidermicoles* or *Epidermoptinæ*, and the *Sarcoptidæ cysticoles* or *Cytoditinæ*.

a. Sub-family of **Analgesinæ.**—The Sarcoptidæ plumicoles are found in nearly every species of Bird—each harbouring one or more forms which are special to it, or which may be found on others.

Often the same species is met with on all the Birds of the same family, and there may be a species of Bird which will carry as many as four distinct species of Acari belonging to three different genera. These Acari live between the barbules of the feathers, principally those of the wings, where, during life, they are found on the quill feathers, sometimes on the retrices or coverts. They are entirely inoffensive.

According to Trouessart—whose labours have thrown great light on the subject—the drying of the feather, by arresting the afflux of fatty matter upon which the insects are nourished, compels them to emigrate towards the root. This drying may be produced either by the death of the bird, by moulting, or by cold. Thus, in winter—as Ch. Robin has noted—very few Acari are found between the barbules of the wing feathers, but numerous nymphæ, and even adults, are observed agglomerated towards the upper umbilicus; sometimes, even at the time of moulting, they seek to reach the subcutaneous connective tissue by the lower umbilicus. Certain species seem to be able to hibernate in the quill. When the bird dies, they often leave the feathers and get on the surface of the skin, or spread themselves into places different to those they occupied during the life of their host.

The Analgesinæ are distinguished by their integuments, which are always symmetrically striated, and in general hardened by the plastrons that are remarked more particularly on the dorsal surface. The legs are rarely all alike, especially in the male, which often has the third pair very thick. The posterior extremity, instead of being simply rounded, is usually more or less deeply lobulated, particularly in the males—although sometimes also in the females—and ornamented with various appendages; the copulatory suckers are nearly constantly present in the males.

The Analgesinæ may be divided into three sub-tribes in the following manner:

Adult female having always the abdomen entire or scarcely bilobate, without any other appendages than hairs.	Males slightly different from the females by the development of the posterior legs	*Pterolichæ.*
	Males having the posterior legs much more developed than the females	*Analgesæ.*
Adult female having the abdomen bilobate, each lobe being terminated by glandiform or setiform appendages ..		*Proctophyllodæ.*

The Sarcoptidæ plumicoles met with on the domesticated Birds belong to the genera *Freyana* Haller, *Pterolichus* Robin, *Falciger* Trouessart, *Dermoglyphus*, Mégnin, *Megninia* Berlese, and *Proctophyllodes* Robin—(*Pterophagus* Mégnin). The characters of these genera are indicated in the following table:

Pterolichæ.	A dorsal cuirass	The two pairs of posterior legs subabdominal		*Freyana.*
		The two pairs of posterior legs lateral	Males alike	*Pterolichus.*
			Males dimorphous ..	*Falciger.*
	No dorsal cuirass			*Dermoglyphus.*
Analgesæ.	Anterior legs spinous			*Megninia.*
Proctophyllodæ.	Female with bulging abdominal lobes, setiferous			*Proctophyllodes* (*Pterophagus*).

On the FOWL are found the *Pterolichus obtusus* Robin; the *Dermoglyphus minor*—*Analges minor*—Nörner, found by Nörner in the quill of the feathers; the *Dermoglyphus elongatus* Még., which we have seen in abundance in the quill feathers; the *Megninia cubitalis* Mégnin, and the *Megninia asternalis* Mégnin. The two last-named species are principally distinguished by the first being a little longer—the female ·40 mm., and the male ·45 mm.—having the abdominal lobes of the male articulated, and furnished with two unequal bristles and three hairs; while in the *Megninia asternalis*, the two bristles are equal and very long, and the abdominal lobes, which are not articulated, are bordered internally by a notched membrane.

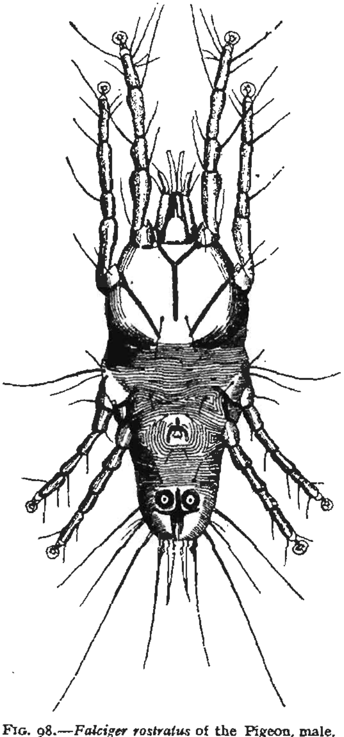

FIG. 98.—*Falciger rostratus* of the Pigeon, male, seen on the ventral surface; magnified one hundred diameters.—Railliet.

In the TURKEY has been found the *Freyana Chanayi* Trouessart; in the PHEASANT, the *Pterolichus obtusus* Robin — which lives also on the Fowl—the *Pterolichus uncinatus* Mégnin, and the *Megninia ginglymura* Mégnin. The two species of *Pterolichus* are distinguished by the extremity of the male abdomen, which is simply bilobate, each lobe having two bristles, in the *Pt. obtusus*; while in the *Pt. uncinatus* it is deeply notched into two prismatic triangular lobes

The only Analgesinæ observed on the GUINEA-FOWL are the *Dermoglyphus varians* Trouessart, and the *Derm. minor—Analges minor*—Nörner, var. *similis*. The first—which is perhaps only a variety of the *Derm. elongatus* found on the Fowl—is distinguished by the presence of a transparent, conical prolongation at the posterior commissure of the anus.

The DUCK harbours the *Freyana analina* Koch, and the *Megninia velata* Mégnin.

The Analgesinæ of the PIGEON are the *Falciger rostratus* Bucholz, the *Megninia asternalis*—which also infests the Fowl—and the *Pterophagus strictis* Mégnin. Zürn has described, under the name of 'Federmilbe der Tauben,' an Acarian which appears to us to be only the *Megninia asternalis*. The Pigeons on which he found it had incredible quantities of it, and died in a state of profound marasmus, which he attributed to this acariasis.

The *Falciger rostratus* offers a special peculiarity. According to Mégnin, it may undergo deviations in its metamorphoses when there occur any changes in the normal conditions of its existence. If, for example, the moulting of the Bird—and consequent dryness of the skin—happens to deprive the parasite of aliment or of necessary warmth, the colony will perish without the intervention of the interesting phenomenon described by Mégnin. The normal nympha, instead of being transformed into a young pubescent male or female, becomes a *hypopous* nympha—that is, it is dilated, and from its envelopes issue an acarian form quite different from the normal shape, the conformation of which is appropriate to a new kind of life. This acarian form is elongated, vermicular, and destitute of rostrum and internal organs. It introduces itself, by the feather-follicles, into the subdermic connective tissue, and contrives to live there for some time by cutaneous absorption. Then, when the normal conditions of its existence are re-established, it finds its way to the exterior by the same channel, assumes its primitive form, and subsequently resumes its regular evolution.

This transitory and accidental form has been named by Mégnin an *adventive* or *hypopial nympha*. It was allotted, before him, to a particular genus, the *Hypodectes* Philippi, in which several species—found on different Birds—were described; they are also probably different hypopial forms of the Sarcoptidæ plumicoles.

These Hypodectes had already been found on several Birds when they were met with, for the first time, on the Pigeon by Ch. Robertson, in 1866. They were chiefly found in the subcutaneous connective tissue around the large veins of the neck, and on the surface of the pericardium; when they were few in number, it was only in these two regions they were located. Robertson examined a considerable number of Pigeons, wild and tame, and rarely found them free from these Acari.

Slosarski—quoted by Mégnin—studied them in 1872, and made a new species of Hypodect, which he designated *H. columbæ*.

The presence of these hypopial nymphæ in the subcutaneous connective tissue does not cause any appreciable disturbance, and appears to have no influence on the health.

b. Sub-family of the **Epidermoptinæ**.—Rivolta, Caparini, Friedberger, and Railliet and Lucet, have observed a cutaneous acariasis of Fowls which they considered of a psoric character. It was due to two allied species, for which Rivolta created the genus *Epidermoptes*. One is the *E. bilobatus*, and it has been regarded by Caparini and Friedberger as a Symbiot—*Symbiotes avium* Caparini.

The other species—first seen by Rivolta—is the *Epidermoptes bifurcatus*

The Epidermoptinæ are very small, and present the facies of the Sarcoptidæ plumicoles, especially the genera *Pterolichus* and *Pteronyssus*. But their teguments and epimeres are always colourless, or very faintly tinged.

These Acari usually live on the surface of the skin, at the bottom of the plumage among the down. In certain circumstances, they multiply to excess, and their presence coincides with an intense pityriasis, which they may occasion.

From published observations, the Epidermoptes have been found in considerable numbers on diseased Fowls. In the parts which were

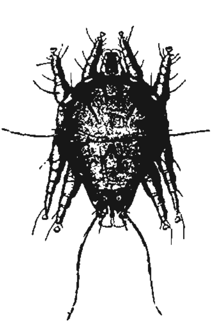

FIG. 99.—*Epidermoptes bilobatus* of the Fowl ; male, seen on the ventral surface ; magnified 150 diameters.

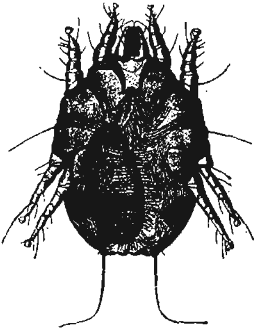

FIG. 100.—*Epidermoptes bilobatus* of the Fowl ; female, seen on the ventral surface ; magnified 150 diameters.

affected, the skin was covered with large, thin, pale-yellow, stratified scales, which formed a sort of embedded horn inside the tube of the feathers, at the points where these were implanted (Caparini). The skin was also covered with dry, dirty, greyish-yellow crusts, from 1 mm. to 1·5 mm. thick, similar to bread-paste. These were on the bare places, and especially on those which are quilled, and at the base of the erect feathers (Friedberger). The *Epidermoptes bilobatus* and *bifurcatus* cause a ' furfuraceous scabies,' characterized by the production of dirty yellow scales, which are especially accumulated at the base of the feathers (Rivolta). Over the entire surface of the body, with the exception of the head, there are crusted patches which may be of the dimensions of a four-shilling piece and a thickness of 5 mm. or 6 mm. ; these contain the *Epi-*

dermoptes bilobatus, associated with the *Sarcoptes lævis*, var. *gallinæ* (Railliet and Lucet). The malady may occupy various points of the surface of the skin, and exceptionally the head (Caparini); the head and neck (Friedberger); the head, neck, region of the crop, armpits, wings, and chest (Rivolta).

In at least several instances, the Epidermoptes were inoffensive, and did not produce the lesions that have been described. Thus, on some pieces, preserved in alcohol and obtained from a fowl, Caparini has remarked the presence of the fungus of favus, which was evidently the cause of the dermatosis. Trouessart has found the *Epid. bifurcatus* on a Fowl, the skin of which was healthy. But we have met with the *Epid. bilobatus* in considerable numbers on a cachectic Fowl, the skin on the trunk of which was covered by a whitish squamous layer resembling the crumb of dried bread.

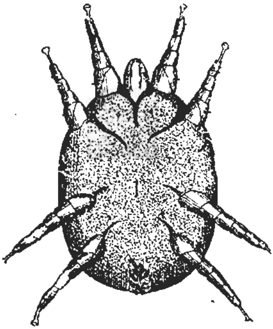

Fig. 101.—*Cytodites nudus* of the Fowl, seen on the ventral surface; magnified one hundred diameters.—Railliet.

In cases of dermatosis supposed to be caused by the *Epidermoptes*, it will be well to make certain if the disease is not rather due to favus.

c. Sub-family of the **Cytoditinæ.**—The Sarcoptidæ cysticoles, or Cytoditinæ, live exclusively on Birds—in the sub-cutaneous or intermuscular connective tissue, in that surrounding the respiratory organs, or in the air-sacs. Notwithstanding their deep habitat, we think it useful to study them here, when describing the other acariases. They are distinct from the hypopial nymphæ of the Sarcoptidæ plumicoles mentioned above, and are divided into two genera—*Cytodites* and *Laminosioptes*.

The first were seen in 1859, by Gerlach, who considered them to be Sarcoptes. They were again found in 1864, by Zundel, and in 1868 by Vizioli, who described them, as well as the second. They have since been met with by a number of observers.

The genus **Cytodites** (χύτος, a cavity) was established in 1877 by Mégnin, who justly separated it from the genus Sarcoptes, to which this form had been allotted by Gerlach and Vizioli. But there was no sufficient taxonomic reason for his proposing, at a later period, to exchange this name for that of *Cytoleichus*. Only one species is known—the **Cytodites nudus** (Vizioli, *Cytoleichus sarcoptoides* Mégnin, *Sarcoptes Gerlachi* Rivolta).

This Acarian has a rounded, whitish, and nearly glabrous body without visible striæ, prolonged in front by a conical rostrum, without cheeks, which

forms a tubular sucker. The legs are strong, conical, elongated, composed of five articles, which are disposed as in the Sarcoptes, and all are terminated by a sucker with a simple pedicle. The *male* is about ·45 mm. long and ·30 mm. broad, and has a conical penis in front of the anus. The *ovigerous female* is ·56 mm. long, and about ·40 mm. broad; she shows a vulva—tocostome—in the form of a longitudinal slit between the two posterior pairs of legs; it is ovoviviparous or oviparous, and may produce larvæ or eggs, according as the latter remain for a long or short period in the oviduct.

The Cytodites species inhabit the air-sacs of the Gallinacei, and especially Fowls and Pheasants, and by reason of their relatively greater size and their white tint, they are readily seen by the naked eye. They enter the bronchi, and even reach the air-canals in the bones. Gerlach has attributed to them the enteritis he witnessed among Poultry, in which he found them; and Zundel believed they caused enteritis and peritonitis. Zschokke has seen them in the lungs, trachea, and anterior air-sacs, in the midst of yellow gelatinous masses, deposits of false membranes, and abundant quantities of mucus; but he was not certain whether there was not a mere simple coincidence between this diphtheria and the internal acariasis. The disease ran the course of a contagious affection, and was rapidly fatal.

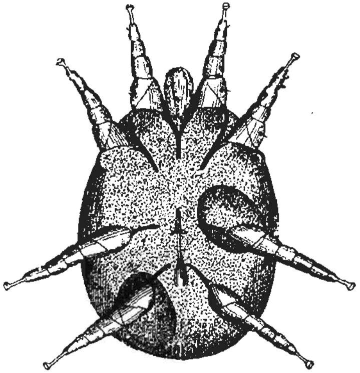

FIG. 102.—*Cytodites nudus* of the Fowl; an ovigerous female, seen on the ventral surface; magnified one hundred diameters.—Railliet.

At the autopsy of several Fowls from the same poultry-yard, which had been ill for a long time, Holzendorff found in the lungs, liver, kidneys, etc., a great number of yellow, miliary nodules, and in the thorax innumerable parasites (Cytodites), which were also recognised in the nodules.

But the Cytodites species often exist in large numbers in the air-sacs, without betraying their presence during the life of their host; and it is only when they are extremely numerous, and crowding in the bronchi, that they may cause fits of coughing by irritating the mucous membrane. Mégnin has seen them on one occasion cause death by congestion, obstruction of the bronchi, and asphyxia.

The genus Laminosioptes (Mégnin) contains only one species—the *L. cysticola* (Vizioli). It is an Acarian with an oblong body more than twice as long as it is broad, having several pairs of bristles on the upper surface and a long pair at the posterior extremity. It is divided by a circular transverse furrow into two portions; the anterior carries the rostrum and the two first pairs of legs; the posterior has the two other pairs, the anus, and the orifice of the genital organs. The integument is finely striated transversely, and the colour is greyish. The legs are short, glabrous, and provided with suckers having a simple pedicle; the suckers are temporary on the two anterior parts, persistent on the posterior pairs. The rostrum is analogous to that of the Sarcoptes; the anus is sub-abdominal. The male is ·22 mm. long and ·10 mm. broad; it has the penis between the anus and the base of the posterior legs. The *ovigerous female* is ·25 mm. long and ·11 mm. broad; it has its tocostome between the bases of the two pairs of posterior legs.

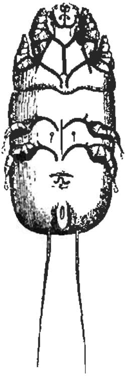

FIG. 103.—*Laminosioptes cysticola* of the Fowl; male, seen on the ventral surface; magnified 200 diameters.—Railliet.

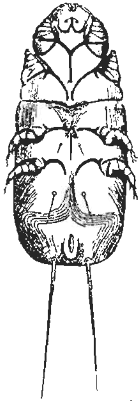

FIG. 104.—*Laminosioptes cysticola* of the Fowl; ovigerous female, seen on the ventral surface; magnified 200 diameters.—Railliet.

The Laminosioptes cysticola is special to the Gallinacei; it lives in the connective tissue, and does not appear to produce any lesions capable of affecting the health of the Birds. Nevertheless, when many exist on a host, they cause irritation of the subcutaneous connective tissue with the formation of nodules, in which may be found the dead parasites. These nodules—first noticed by Voigtlander, then by Vizioli, and other observers—are yellow, oval bodies from ·25 mm. to ·50 mm. and 1 mm. long, and are sometimes so abundant that as many as a hundred will be found on two and a half square centimetres of surface (Vizioli). The contents are

soft, granular, and adipose or calcareous—in fact, much like those of tubercle. They may be found on the abdominal viscera, and in the peritoneum, as also in the muscles and beneath the skin; in the latter instance, they can be seen through the integument, and may even be discovered among the epidermic scurf (Rivolta). They have been seen in Fowls, Pheasants, and Turkeys. Heller, of Kiel, states that he has met with them in 70 per cent. of the Fowls, he has examined. They are especially frequent in old and cachectic birds.

ARTICLE II.—Psoric Acariases.

The psoric Sarcoptidæ that live on Birds belong to the genus Sarcoptes; but they offer external characters and a kind of life that justifies their union into one section or sub-genus—the *Knemidokoptes* of Fürstenberg (*Dermatoryktes* Ehlers).

These parasites have the body orbicular, destitute of squamiform prominences and of spinules on the notogastrum. Each of the epimeres of the first pair of legs sends over the back a prolongation, which joins its congener in such a manner as to limit a rectangular plastron. The anus is situated at

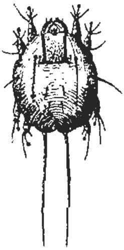

FIG. 105.—*Sarcoptes mutans* of the Fowl; male, seen on the dorsal surface; magnified one hundred diameters.

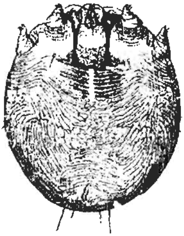

FIG. 106.—*Sarcoptes mutans* of the Fowl; ovigerous female, seen on the dorsal surface; magnified one hundred diameters.—Railliet.

the posterior part of the notogastrum. The males, nymphæ and larvæ, are provided on all the legs with the suckers that characterize the other Sarcoptes, which they much resemble in their general form. The pubescent and ovigerous females are globular in shape, and almost glabrous; their legs—which are very short and conical—are destitute of suckers, and terminate in two unequal hooklets. They are ovoviviparous.

The Sarcoptidæ avicoles actually known have been divided into three species, only two of which live on the domestic Birds—these are *Sarcoptes mutans* and *Sarcoptes lævis*.

The **Sarcoptes mutans** (Rob., *Knemidokoptes viviparus* Fürst.) has—in the female—the dorsal surface covered with mammiliform integumentary prominences; the length of the parasite is ·40 mm. to ·45 mm., and breadth ·35 mm. to ·38 mm., while the male is ·20 mm. long and ·15 mm. broad, and is destitute of copulatory suckers, like all the other Sarcoptes with the exception of the following species.

This Sarcopt lives on the Fowl, and causes the *leg scabies.*

The **Sarcoptes lævis** (Railliet) has no dorsal integumentary prominences in the female, but very fine parallel, regular ridges; the male has two small copulatory suckers. The dimensions are less than in the preceding species (Figs. 108, 109, 110).

This species comprises two varieties:

S. lævis, var. *columbæ.*—The epimeres of the first pair of legs are joined in a Y shape in the male, and are united in the female by a transverse piece in the form of a circumflex accent. *Male* from 140 μ to 170 μ long, and 110 μ to 120 μ broad. *Ovigerous female* from 270 μ to 310 μ long, and 230 μ to 270 μ broad. Discovered by Railliet and Cadiot, in 1855, at the base of the feathers of a messenger Pigeon.

S. lævis, var. *gallinæ.*—The epimeres of the first pair of legs remain free in the female. *Male* from 170 μ to 180 μ long, and from 120 μ to 130 μ broad. *Ovigerous female* from 310 μ to 350 μ long, and 270 μ to 300 μ broad. Discovered by Railliet in 1886 on a Fowl.

§ 1.—Scabies of the Legs.

Known for a long time as a dermatosis, the scabies of Fowls (*gale des pattes, grappe, blanc*) has only been considered as an acariasis since 1859, when Ch. Robin and Lanquetin discovered the parasite—the *Sarcoptes mutans*—and when Reynal and Lanquetin gave a description of the disease. It has since been studied by numerous authorities, who have witnessed it on Turkeys, Pheasants, Partridges, and small birds in aviaries—such as Bullfinches, Goldfinches, Paroquets, etc. (Mégnin).

Symptoms.—Reynal and Lanquetin state that the malady may be seated on the head or the legs, or both regions at the same time. But those who have followed them—Unterberger, Fürstenburg, Mégnin, etc.—have only seen it on the legs. We have shown that in the observations of Reynal and Lanquetin a serious mistake was made through the co-existence of favus—seated on the head—and scabies—located on the feet. The result of all the reliable observations goes to prove that this psoric affection is exclusively confined to the legs.

The *Sarcoptes mutans* lives under the epidermic scales covering the anterior surface of the tarsi and the upper part of the toes, and by its presence it soon sets up an irritation that is manifested in the elevation of these scales, owing to the formation of a white powdery matter that remains agglutinated by the exuded serum. There are gradually formed rough crusts, which are greyish externally, white internally, irregular in shape and mammillated, and which finish by invading the whole of the digital region. They are few on the inferior face of the toes and behind the tarsi; they are very adherent, and when detached, the irritated and bleeding skin, somewhat honey-combed, is exposed. In examining these crusts by means of a hand-lens or microscope, the inferior surface is seen to be excavated by an infinite number of alveoli, each of which is moulded, as it

were, on the body of the female Sarcopt lodged therein. For they are nearly always ovigerous when they occupy these depressions, in which they lie squat and immovable, the ventral surface being turned towards the crust; they are recognised by their regular form and the rusty colour of their epimeres. Larvæ, nymphæ, pubescent females, and a very small number of males, wander beneath the crusts; no eggs are found except by chance, and these have escaped from the ovigerous females which have been accidentally crushed.

The entire substance of the crust is so excavated by cavities that it is quite spongy, and greatly resembles the crumb of dried bread The alveoli become smaller as they are more superficial, owing to drying of the crust, or external pressure on it; but the deeper ones alone contain the Sarcoptes, which abandon the cavities as these become old, and therefore farther removed from the moist surface of the derma There are no furrows, as in the other forms of sarcoptic scabies; but an epidermic proliferation takes place around the motionless ovigerous female, which has penetrated beneath the epidermis after copulation.

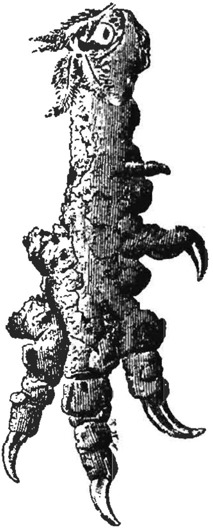
FIG. 107.—The foot of a Fowl affected with scabies.

The prominence of the crusts exposes them to cold, and to damage that breaks them, and causes a sanguinolent effusion into the fissures at their base; the movements of the joints—otherwise much compressed and restrained—also bring this about. Progression and standing are difficult; the Bird is lame, arthritis appears, and it is not rare to see a phalanx, or even an entire toe, fall off.

The disease is accompanied by a moderate degree of pruritus, which is more intense at night or during warm weather, and which the Fowl manifests by scratching, and often attacking the affected parts with its beak.

This scabies runs a very slow course, and may continue for six or eight months, or even a year Gradually the general health is affected; the Fowls become emaciated, cease to lay, lose their appetite, and succumb to marasmus or to an intercurrent affection.

The most usual complications are favus, diphtheria, and psoro-

spermosis; but it is to the two last-named diseases, and to tuberculosis, that the hepatic, and sometimes the pulmonary tubercles mentioned by Reynal and Lanquetin as lesions of the scabies, really belong.

In a cock affected with sarcoptic scabies, Csokor found the conjunctivæ swollen and red, and discharging much purulent mucus; though the ocular globe was bright and the vision intact. The use of an appropriate collyrium cured this condition.

Etiology, Contagion.—Contagion—the real cause of the malady—occurs through the cohabitation of healthy with diseased Fowls; the agent being the Sarcoptes mutans in its various stages, save that of the ovigerous female, of which the immobility is nearly absolute. When the Poultry do not get much exercise, and are confined in small places, they run much risk of being infested by wandering acari from the manure. However, the contagion is not subtle, for Fowls remain a long time healthy in the midst of diseased ones; and according to the observation of Friedberger, some very severely affected ones may be seen in poultry-yards where all the others are free from the malady.

Breed appears to us to have a real influence in the etiology of the disease. Common-bred Fowls resist contagion much longer than exotic breeds. Reynal and Lanquetin observed that the malady is more frequent in the Cochin-China breeds and its varieties than in the Dorking and Brahmapootra breed. Perhaps this predisposition is related to the thinner skin in these breeds.

The disease is contagious for the Gallinacei, Passeres, and Climbers; it has not been observed on Palmipedes. Reynal and Lanquetin represent it as transmissible to Man, Equines, and Ruminants; but the evidence they furnish in support of their statement refers rather to the Dermanyssus, and not to the *Sarcoptes mutans*.

Treatment.—To prevent the infection of healthy Fowls, it is necessary that the diseased be separated from them, and the locality these occupied be thoroughly disinfected by washing with medicated boiling water, such washings to be extended to the perches, beams, etc., of the roost.

The medical treatment should have for its object the removal of the crusts, and the prevention of their reappearance. They may be removed by means of the finger-nail, or a small brush dipped in tepid water; but this is painful for the Bird. It is preferable to soften them in a tepid alkaline bath for a few minutes, then remove them without causing bleeding; then, when the parts are dry, a layer of Helmerich's pomade is to be applied to them. Generally, two days afterwards this ointment may be washed off by means of soap, when a cure will be found to have been effected.

Carbolic acid ointment—1 part of carbolic acid to 10 or 20 of lard; creosote ointment—1 of creosote to 20 of lard; benzinated oil—1 of benzine to 10 of sweet oil; iodine, and petroleum ointment have also been recommended. But these means, though more active than Helmerich's pomade, may have a bad effect on the general

health of the Fowls, especially if they are young. The balsam of Peru is not inconvenient; its odour is agreeable and its effect certain; it is to be applied once a day for two or three days. When the disease is cured, it may be advisable, in order to calm the irritation which sometimes persists in the skin, to smear over the parts with sweet oil, cream, vaseline, glycerin, butter, etc.

§ 2.—Scabies of the Body, Depluming Scabies.

This form of scabies was first observed by Railliet and Cadiot, on a carrier-Pigeon from Brussels. This bird had been affected for more than a year with a disease of the skin characterized by somewhat acute irritation, and accompanied by an abundant production of epidermic scurf and shedding of the feathers, which broke off at the surface of the epidermis, the remaining part becoming a powdery mass which the slightest pressure extruded. The Sarcoptes were found at the base of the feathers. The affection yielded to the daily application of sulphur lotion, continued for a certain time. Friedberger has published a similar observation.

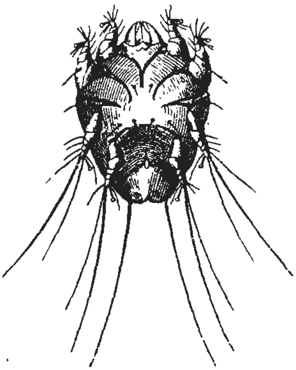

Fig. 108.—*Sarcoptes lævis*, var. *gallinæ*; male, seen on the ventral surface; magnified 200 diameters.—Railliet.

Railliet for the first time observed scabies of the body of Fowls in 1868, in a poultry-yard in Normandy. He has since found it in the environs of Paris, and is informed that it is very common. We have seen it affecting Poultry in the neighbourhood of Carcassonne.

'The disease appears in poultry-yards in consequence of the introduction of one or more affected Fowls, and is transmitted with such remarkable rapidity that in a few days the whole run is invaded. It usually begins on the rump, then spreads to the neighbouring parts—thighs, back, and belly; and often the head and upper part of the neck are early affected. The feathers fall off at all these points, and finally the skin is left denuded over a vast extent of surface; though the larger feathers of the tail and wings, as well as those of the wing-coverts, are generally retained. The

denuded skin always presents a normal appearance—remaining supple, smooth, and not perceptibly thickened. In pulling out the feathers that remain in the vicinity of the invaded parts, it is easy to find—in Pigeons—a mass of whitish epidermic layers, occupying the limit of the quill and the shaft, and containing a variable number of Sarcoptes' (Railliet).

As a rule, the health is not impaired, though sometimes the Fowls become emaciated, the skin around the croup becomes of a bright-red colour, egg-laying is diminished, and the flesh is insipid to eat. The malady is usually more intense in cocks, which sometimes die in a cachectic state.

This body scabies prevails most in the spring and summer, and disappears more or less completely at the commencement of autumn, usually returning in March or April. It appears to us that contagion is more particularly effected during copulation of the Poultry, the region of the rump being that which is nearly always the first to be invaded. A cock affected with the malady will rapidly infect all the Fowls in the poultry-yard.

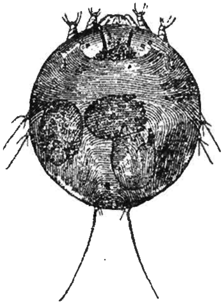

FIG. 109.—*Sarcoptes lævis*, var. *gallinæ*; ovigerous female, seen on the dorsal surface; magnified one hundred diameters.—Railliet.

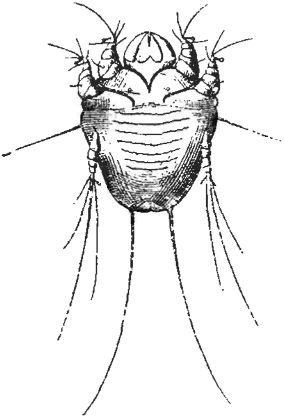

FIG. 110.—*Sarcoptes lævis*, var. *gallinæ* larva, seen on the ventral surface; magnified 200 diameters.—Railliet.

This somewhat common disease has often been mistaken for an abnormal moulting, early or late; and at least the majority of cases of *piquage* ought probably to be ascribed to it. This *piquage*

is an affection which prevails in poultry-yards, and is recognised by the scanty and miserable condition of the plumage. The Fowls naturally peck out their feathers, being impelled thereto, not, as is generally believed, by mischief or imitative habit, but by a sensation of pruritus or *malaise*, which causes them to render each other this reciprocal service.

The treatment of this 'body scabies,' or 'depluming scabies'—as Railliet has termed it—is simple, and somewhat the same as that recommended for dermanyssic scabies and phthiriasis.

CHAPTER VI

CUTANEOUS HELMINTHIASES

AMONG the domesticated animals, the Horse, Dog, Ox, and Sheep are alone mentioned as being attacked with affections due to Nematodes living on the surface of the skin, in its substance, or in the subcutaneous connective tissue.

These Nematodes have all been placed in the genus **Filaria** (Müller), thus characterized:

Body slender, very elongated, and 80 to 100 times longer than it is thick. Mouth of variable form, sometimes encircled by lips, and often furnished with papillæ. Œsophagus thin, and not forming a distinct ventriculus. *Male*, tail curved or spiral, sometimes provided with lateral membranous wings; nearly always furnished with four pre-anal papillæ and a variable number of post-anal ones; one or two unequal spicules. *Female* provided with a double ovary, and a vulva situated very near the mouth; most frequently ovoviviparous.

The Filariæ are more particularly parasites of the serous membranes and the subcutaneous connective tissue. They are also included among the worms very rarely met with in the intestines of the Horse and Dog.

ARTICLE I.—**Parasitic Dermatorrhagia.**

It has been known for a long time that the Horse is liable to small local hæmorrhages on various parts of the surface of the body. According to the bibliographic researches of Leymacher, the Chinese were aware, from the remotest antiquity, of a breed of Horses in Khodang which *perspired* blood. Ercolani has collected a number of observations by different practitioners, of similar hæmorrhages occurring on the Horse and Ox, to which he has given the name of *Hæmathydrosis* (blood-sweat); but the disease has been only well known since Drouilly and Condamine discovered in the hæmorrhagic points a particular Nematode, which they have placed in the genus *Filaria*. We cannot deal, therefore, with the observations made with regard to the Ox, to which animal this discovery has not been carried; nor yet with those hæmorrhages on the limbs, of which Rossignol has furnished an interesting example.

Symptoms.—Parasitic cutaneous hæmorrhage begins with hemispherical, hard, painless elevations, slightly œdematous around their margin, and of the size of a pea to that of a hazel-nut, on which the hairs are erect. They are formed by an accumulation of blood in the superficial layers of the skin, which become ruptured by the pressure, and the blood then passes in streaks along the hairs, and coagulates, the opening by which it escapes being generally at the summit of the tumour, though it is scarcely visible. The hæmorrhage takes place soon after the appearance of the tumefaction—in an hour or two—which then disappears, and everything again becomes normal, though sometimes there is suppuration.

The eruption is especially localized upon the shoulders, the sides of the body, the back, and the sides of the neck and withers. It is very ephemeral, and when the blood has escaped there remains scarcely a trace of the primitive lesion. There are always several nodules at one time, the eruption going on for several days, and gradually subsiding as the elevations become fewer and smaller. Such eruptions happen in starts, at intervals varying from three weeks to a month, during the three or four months of spring; there are none in winter, and in France the affection recovers of itself, and finally disappears in about three or four years.

No general disturbance of the health accompanies or precedes the hæmorrhages; indeed, in some cases, according to Salle, they seem to have exercised a favourable influence on the course of climatic affections to which army remount horses are liable. Lamy, however, who has on several occasions observed termination by suppuration, has seen marked debility occur in these cases. Brunswig has reported a fatal case—a horse commenced to sweat blood over the entire skin, and in such great quantity that on the second day it was dead; while, in 1845, at Mustapha (Algeria), Liautard—quoted by Salle—observed cutaneous hæmorrhages on Mules from Spain, several of which died of splenic hæmorrhage.

We cannot decide whether these exceptional cases were really those of parasitic dermatorrhagia, as its nature is only known since the discovery of Drouilly and Condamine; and before that time it was confounded with all the diseases, otherwise rare, which are accompanied by cutaneous hæmorrhage.

To discover the presence of the Filaria, Drouilly recommends that the hair be shaved off that part of the skin where an elevation is felt. Some hours afterwards, its summit will show an ecchymotic point, which will rupture to allow the blood to escape. Shortly before this occurs, a slight opening should be made in it, when the Worm will be perceived; but it contracts, to bury itself in the connective tissue. Sometimes it has to be sought for as deep as the muscles. 'If it be desired to hasten and to view this migration, a drop of oil of turpentine or a small portion of mercurial ointment should be placed on one of these swellings, which has been previously shaved over its whole surface and beyond; then it will be possible to follow the Worm, either by observing the small ecchymotic streaks

on the skin when it is fine, or in feeling a small cord form under the finger. In twenty-four to twenty-eight hours, a new elevation is certain to appear at 3 cm. to 5 cm. from the first.'

The **Filaria of the hæmorrhagic tumours** (*Filaria hæmorrhagica* Railliet, F. *multipapillosa* Condamine and Drouilly) was discovered and described by Condamine and Drouilly, and has also been seen by Mégnin and Trasbot. The female alone is known.

It is white, filiform, 6 cm. to 7 cm. long, and ·355 mm. broad, gradually tapering in its posterior third. *The mouth is nude; the anterior extremity of the body is covered by a large number of small conical warts, among which* the vulva opens. The embryos—which are extremely numerous—are all formed in the body of the female, which is, therefore, ovoviviparous.

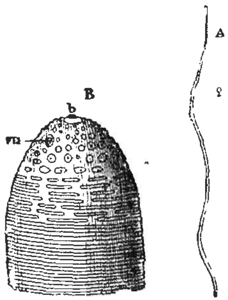

FIG. 111.—Filaria of the Hæmorrhagic Tumours.

A, adult female, natural size; B, cephalic extremity with its warts; *b*, mouth; *vu*, vulva; magnified one hundred diameters. —After Condamine.

Etiology.—In France the malady *has only been observed on Hungarian* Horses, distributed as remounts in regiments of cavalry, and the documents we possess show that it is special to Horses of Eastern origin. 'Thus,' says Trasbot, 'Spinola considered it as peculiar to Horses of the Steppe breed; Ercolani states that Sibald, in his *Histoire Naturelle du Cheval*, affirms that he has often observed it on the white Horses of Tartary. Leblanc, sen., declared at the Veterinary Society, in the short discussion that followed the reading of the interesting paper of Salle, that he had observed it on one of the Russian Horses brought to the Paris Universal Exhibition in 1867; and on that occasion the man who accompanied these animals informed him that it was frequent in that country. Leblanc also remembered that Barthélemy, sen., had often seen it in Germany, during the campaigns of the First Empire, among Horses from the Steppes. And observations recently made in Austria by Leymacher, when he was detached at Laybach in Illyria, to receive the Hungarian Horses purchased by the French Government, and those collected by Salle and Naudin shortly afterwards, when these horses had been sent to regiments, all testify that the cutaneous hæmorrhage is a malady special to Eastern breeds. Bernard states that he has seen the disease among Spanish horses.

Fleming has seen this cutaneous hæmorrhage in North China, affecting Horses from India, and among Arab Horses in Syria. In some cases the bleeding was somewhat profuse, and sufficient to stain the ground upon which the animals stood; but it did not

apparently injure them, the only inconvenience experienced being when the tumours formed on the back where the saddle rests. The affection has been witnessed in England in foreign Horses.

Now that we can attribute this affection to a parasite, it must be admitted that its geographical localization is related to the distribution of this Nematode. But we know nothing of its migrations, but only of its last habitat—the subcutaneous connective tissue. It is possible that the embryos have to undergo evolution external to the body; for it may be mentioned that Railliet unsuccessfully injected a somewhat large number of these embryos—extracted from the body of a Filaria—into the subcutaneous connective tissue of an old Mare.

Diagnosis, Prognosis, Treatment.—The peculiar physiognomy of this affection should not allow it to be mistaken for any other.

The different authorities are nearly unanimous as to its benignity. There is, therefore, little need for resorting to special treatment, all that is required being merely to wash off the blood and keep the skin clean. In the exceptional instances in which debility is induced, a tonic and fortifying régime must be adopted. The only measure to be recommended, is abstention from work that necessitates the application of harness to parts on which the eruption is seated.

ARTICLE II.—**Summer Sores of Horses.**

Synonyms, History.—*Estival Sores, Granular Sores, Granular Dermatitis.* We owe to H. Bouley the first description of this affection, in 1850. He considered it to be a particular complication of cutaneous wounds, under the influence of the heat of summer; and this opinion was for a long time current. In 1868 Rivolta clearly indicated the parasitic nature of these wounds; but his observations remained unsupported until a few years later, when Laulanié confirmed them; and now it seems to be well established that the 'summer sores' ought to be ascribed—at least, in a great number of cases—to the presence of a larval Nematode in the substance of the skin.

Symptoms.—The 'summer sores' have been considered, up to the present time, as a complication of ordinary wounds, due to the hot weather of summer. Therefore at their commencement—such as we know it—they do not offer anything special in their character. When they begin to attract attention, they show a tendency to spread, and are covered with a soft, pulpy layer; the granulations are of a reddish-brown colour, and separated by furrows full of thin pus, or of the pulpy matter that covers the whole. The centre of the sore is soft, and easily penetrated by the finger. In the middle are formed granulations of a yellow colour, composed of fibrous and calcareous matter. The volume of these granulations varies between that of a grain of millet and a pea. Some are superficial, and easily lifted out by simple scratching; while others

are deeper, and are, as it were, *encrusted in the indurated tissue of* the sore.

At first irregular in their form, the sores, in extending, gradually assume a circular contour; their diameter is variable, but is generally limited to three or four centimetres, though some may be a decimetre.

They have no particular seat, but may be found on any part of the body, and especially on those regions which are most exposed to wounds—as has long been observed—such as those on which harness rests, and the extremities of the limbs.

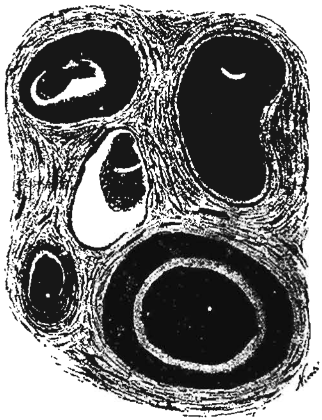

FIG. 112.—Section of a fragment of the skin of a Horse, showing the lesions of granular dermatitis; after a preparation by Laulanié; magnified twenty diameters.—Railliet (inedited).

One of their constant characters 'is the ardent, *insupportable pruritus* which never allows the animal a moment's rest, but compels it to rub, tear, and gnaw with its teeth, to the complete destruction of the sore in which the itching is experienced' (H. Bouley).

Duration, Complication, Prognosis.—These sores are remarkable for their tenacity, as it is quite exceptional to see a spontaneous recovery with the termination of the summer heat. The *duration is always long*, and it appears to be increased by the rubbing to which the animal subjects them; and it often requires two, three, or more *months to control them*, or, at least, to effect their disappearance. And sometimes their cure is only momentary, as they break out again the following summer, on the return of hot weather.

Their resistance and their duration constitute their gravity; while the damage they receive from the patient itself may seriously complicate them, according to their anatomical situation. We have seen open synovial sheath and exfoliation of tendon brought about in this way.

Pathological Anatomy.—The particular tissue implicated in the sore is not so superficial as its appearance might indicate; for it often extends beyond the thickness of the skin, and involves the

subcutaneous connective tissue; in this way it forms a slightly diffused tumour, greater in extent—sub-epidermically—than the cutaneous denudation.

In the pathological tissue, there must be distinguished the special granulations and the neoplasy englobing them. The latter is the result of an inflammatory process, the intensity of which—according to Laulanié—appears to depend upon the period of the year in which the sore is examined. In winter, this observer has found the derma very much thickened, and in a manner sclerous; but in summer the alterations may have a sub-acute character—the derma being infiltrated with embryonic, and more particularly fibro-plastic, elements, abundantly interposed between the connective or fibrous tissue fasciculi; in both conditions the smaller arteries are in process of obliteration. The caseous masses of the granulations are surrounded by a disjunctive zone—the elements of which are more or less altered by the caseification changes, and by a fibrous circle undergoing fibrous evolution.

The granulations are composed of a caseous or calcareous mass, and are especially interesting from the presence in their centre of a Nematode, or its débris; or merely the spiröid space it occupied, which is now only an irregular cavity with broken outlines. Rivolta—who has been able to study these granules at the commencement of their formation—has succeeded in isolating a Nematode, which had also probably been seen by Ercolani and Semmer.

Ercolani has met with the embryos of the Nematode in a Horse on which were umbilicated crusts about a centimetre broad, and very adherent by their deep surface, which was attenuated to a kind of pedicle fixed in the derma. These crusts—which implicated the entire thickness of the skin—were localized on the lower surface of the body along the *linea alba*, where were also seen many bare patches, and others on which the hair had grown again, but was white. The deep portion of each crust looked like a white matted tissue, and was composed of a loose connective tissue, in the midst of which were the very minute Nematodes. Ercolani characterized them as keeping the caudal extremity doubled under the body, and making frequent movements of abduction. Semmer reports having found numerous Nematodes between the derma and epi-dermis in a horse affected with a dermatosis which was considered to be a psoriasis.

It is a very fine Worm, which may attain a length of 3 mm., and the head of which is sometimes a little distinct from the body; the tail is attenuated, terminated in a point, and margined by fine notches. The mouth is orbicular, and appears to be provided with lips. A short distance from the head is seen an opening. The anus is placed at the point where the body becomes attenuated to form the tail. The skin is delicately striated transversely.

This is evidently a larval Nematode. Rivolta has recently proposed to name it the *Dermofilaria irritans*, but Railliet has rightly reduced this designation to that of *Filaria irritans* Riv.

Etiology.—Investigations are not yet sufficiently numerous to allow it to be affirmed that every granular or summer sore must be due to this Nematode. But the discovery of this element perfectly accounts for the physiognomy of the affection—its periodicity, disappearance in winter, recrudescence in summer—related to 'the natural congestion resulting from the increase in temperature; so that the parasitic granulations, placed in the centre of the tissue which has become more irritable, develop the first movement in the chronic inflammation that is accompanied by pruritus, which induces the animal to scratch itself. Hence the excoriations and the sores, which are all the more obstinate as the denuded derma is more impressionable, and the more readily submits to the irritating effects of the granulations' (Laulanié).

With regard to the inefficacy of treatment, this is owing to the deep situation of the parasite, which is protected by the caseous mass surrounding it.

Its mode of introduction is still unknown. Rivolta admits that it penetrates the integument from without to within, and he ascribes, as a predisposing influence, the uncleanliness of the animals and the stables. Mégnin has even affirmed—though without proof to support the statement—that the Nematodes of the sores are only the embryos of the *Oxyuris curvula* Rud., an intestinal parasite of the Horse. This assertion of Mégnin may have been inspired by an observation of Pflug, relative to a Horse that had numerous thick crusts at the base of its tail, which were very pruriginous. These crusts contained the ova of the *Oxyuris curvula* at different stages of development, the parasite itself being found in the fæces. Pflug thought that the Oxyuris of the rectum induced acute pruritus of the anus, which caused the Horse to rub itself, and so to lead to the deposition of the ova on the walls of the stable, whence they would be taken up by the hairs of the tail; they would then produce embryos which would continue to live under the protection of the crusts, and with the help of the warmth of the skin. But, as Railliet has remarked, the parasites of the 'summer sores' occupy the centre of the granulations, and it is consequently difficult to admit that they are only an epiphenomenon, the granulations themselves constituting the essential element in these wounds. It is probable that, according to Laulanié, the parasite is introduced—in the form of ovum—into the digestive tract, and subsequently penetrates into the blood circulation.

Besides the parasitism, a preponderant influence has been attributed to the summer heat; and it has been admitted that it causes the drying-up of the pus, and the union of its corpuscles in the form of concretions. Friction has also been considered as very important in this etiology. The malady is more frequent in hot countries—Algeria and Italy, for instance—and the Ass appears to be more exposed to it than the Horse, the extremities of the limbs being chiefly attacked in that animal.

Treatment.—An essential indication in the treatment is to

prevent the animal yielding to the pruritus that maddens it; and with this object in view, means of restraint are employed, the nature of which is subordinate to the situation of the sore.

Many agents have been tried in the treatment of the sores, but the majority of them have proved of no value. Among those which have less frequently failed is *continuous irrigation with cold water*, recommended by Quin when the seat of disease permitted. The same authority has counselled frictions of glycerin, but these two methods of treatment ought to be employed for a long time—fifteen days, at least. Caustics constantly fail, though Rey obtained excellent results from the yellow sulphide of arsenic, or orpiment, in powder. He took up some of this on the moistened end of his finger, and spread 'an imperceptible layer' over the sore. One application was sufficient; the pruritus completely ceased, the wound dried, and a scab formed that became detached in eight or ten days, leaving a simple wound, which rapidly cicatrized.

Blaise has had equal success with ether, chloroform, and iodoform, with which he dressed the surface of the sore for about ten minutes every twenty-four or forty-eight hours—applying a protective layer of collodion over it. The cure was complete in about fifteen days.

Following this affection, may be placed the filariasis observed by Baruchello among a large number of horses belonging to a cavalry regiment. It was seated almost exclusively beneath the hairs on the withers, on the neck, beneath the forelock, and at the base of the tail; and it was manifested *during the spring and summer. It consisted of small dark-grey tumours*—isolated or confluent—varying in size from that of a millet-seed to a pigeon's egg. These tumours soon softened in their centre, which became yellow, ruptured, and allowed pus to escape. This suppuration was followed by sloughing of a portion of the skin. There was no pruritus, and only a certain amount of sensibility on pressure. In the pus, Baruchello discovered a number of extremely slender agamous Nematodes, from 5 mm. to 15 mm. in length, and the most developed of which were enlarged at their cephalic extremity, or terminated in a blunt point, in the centre of which there was an orbicular mouth, apparently provided with lips. The body gradually became attenuated to the tail, which had the anus at its base. Some of them, shorter and thicker, had the cephalic extremity less distinct, had no caudal point, and the anus was terminal; these continued their development in water, and realized the preceding form.

A cure was effected, principally by the application of an ointment composed of vaseline, 2,000 grammes; sulphur, 400 grammes; saturated alcoholic solution of carbolic acid, 120 grammes; corrosive sublimate in solution in q.s. of glycerin, 12 to 25 grammes.

Three horses attacked with this filariasis fortuitously died during the course of the disease, and in their peritoneal cavity a very large number of *Filaria papillosa* Rud. were found. For this reason, Baruchello was inclined to believe that this cutaneous *Helminthiasis is due to the embryos of this Filaria*.

The veterinary surgeons of the English army in India are very often troubled by a skin disease of Horses which is extremely refractory to treatment. Very pruriginous, it causes much irritation, shedding of the hairs, wrinkling and thickening of the skin, and an abundant formation of scurf; while the rubbing and gnawing induced by the itching tends still more to increase the alteration in the skin. The disease is usually manifested on the sides of the neck and shoulders, on the chest, and at the base of the tail. Its nature is not well known, and numerous hypotheses have been formed on the subject. In 1884,

Gunn reported that he had found a parasitic Worm every time he examined the crusts which appear in the course of the affection, but the description he gave of the parasite is absolutely obscure.

It may be added that 'Cobbold has described, under the designation of *Pelodera Axei*, a Worm found by Axe in the hoofs of horses affected with "seedy toe"; but we are of opinion that this is a thread-worm found in manure, and has no connection with the disease' (Railliet).

Article III.—**Dracontiasis (Filaria of Medina).**

The **Filaria of Medina** (*Filaria Medinensis* Linn., *Dracunculus Persarum* Kaempfer) is chiefly known as a parasite of Man. It has, nevertheless, been sometimes found in other animals, among which are the Dog, Horse, and perhaps the Ox. It has been very often named the *Dragonneau* (*Dracunculus*), and hence the designation *Dracontiasis* given to the disease it determines. In the adult state, the female only is known.

It is a white Worm, on the average from 50 to 80 centimetres long, and, according to certain authorities, it may attain a length of 4 metres (more than 12 feet). Its diameter—uniform throughout—varies between ·5 mm. and 1·7 mm. The anterior extremity is blunt, and shows a *cephalic shield*—an irregular surface, elongated transversely, which has the mouth in its centre in the form of a triangular slit, having at its margin two papillæ—one dorsal, the other ventral—and behind the latter, on the border of the shield, are six other papillæ, nearly equidistant. The posterior extremity terminates in a blunt point, at most 1 mm. in length, curved like a hook on the ventral surface. The digestive apparatus is well developed in young individuals, but is atrophied in adults, being empty and reduced to a slender tube that gradually disappears behind, without opening into an anus. The cavity of the body is almost completely occupied by a uterus gorged with ova and embryos The latter—hatched in myriads in the body of the female—can only escape by rupture of the Worm; the vagina and vulva, which were doubtless present in early age, having completely disappeared. These embryos measure ·50 mm. to ·75 mm. long, and 15 μ to 25 μ in diameter; they are cylindrical, scarcely attenuated in front, but in the posterior third of their length they taper to a very fine tail.

The Filaria of Medina is special to hot countries. In Asia it is observed not only at Medina, but throughout nearly the whole of Arabia and in India. In Africa it is common on the coast of Guinea, hence the name *Guinea Worm* given to it by the English; it has also been observed in Upper Senegal, and more especially in East Africa—Abyssinia, Nubia, Egypt, Kordofan, Darfour, and Senaar. It was introduced into South America by the negroes at the time of the treaty, and it has become endemic in Guiana and some localities in Brazil.

This Worm is found in the subcutaneous connective tissue, and in Man is met with chiefly in the legs and feet; though sometimes it is also seen on the head, neck, trunk, hands, and even in deep-seated organs. Usually rolled up in a spiral manner, it causes the formation of superficial tumours, which are occasionally very painful, and most frequently become abscesses. A certain number of observations have established the fact that it can also develop in the Dog, Horse, and Ox, among the domesticated animals.

DOG.—The Filaria of Medina has been observed in the Dog by Doerssel at Buenos-Ayres and Curacao. Smyttan, Forbes, and Griffith have seen it in India, and Clot-Bey, Pruner-Bey, and Innes and Piot in Egypt. We borrow from Railliet the following symptomatology:

'The *Filaria Medinensis* is most frequently met with in the limbs; it is located in the subcutaneous connective tissue, parallel with the long bones, and more rarely in the superficial portions of the intermuscular connective tissue.

'The Worm first manifests its presence by the development of an oblong, flattened tumour, feeling to the touch like a skein of thick twisted cord. This tumour is indolent at the beginning, and sometimes forms a very apparent prominence; it gradually becomes painful, often to such a degree that the Dog threatens to bite when an attempt is made to explore the diseased region. The animal becomes restless and agitated, lying down and getting up every instant, licking the tumour, and, indeed, manifesting all the signs of a most intense local pain.

'Then there occur—at a variable point of the tumour—one or more small abscesses, which soon open, and give issue to a small quantity of purulent serosity. The wound becomes fistulous, and in time gives exit to the Worm, one of the extremities of which protrudes from the opening. Sometimes an abscess forms some distance from the tumour, and then the inflexions of the Filaria can easily be followed beneath the skin, as it has passed through the connective tissue without producing any marked degree of inflammation on its course. The pain—no doubt caused by the movements of the Worm—does not seem to be constant; for varying periods the Dog remains quiet, but at other times it howls, and furiously licks the wound, sometimes seizing the worm by its teeth and trying to extract it, though the suffering this entails compels it to desist. However, one of the Dogs that Piot attended succeeded in freeing itself from one of the parasites by gradual traction, *the inflammation assisting the operation.*

'In Man, rupture of the Filaria—which at times happens during extraction—is a very grave, often a fatal, accident. It does not appear to be so with the Dog, as the Worm simply retracts within the wound without the pain or inflammation being increased, the parasite ultimately appearing at the same fistulous opening, or it makes a new passage for itself through the integument.'

The number of Filariæ found in the same individual varies from one to five.

HORSE.—The *Filaria Medinensis* has been observed in the Horse by Clarkson (1837), Fleming (1861), and Burke (1882). In each of these instances the Worm was situated in one of the limbs—at the lower part of the posterior pastern in Clarkson's case, at the external aspect of the hock in Fleming's, and below the carpus in Burke's. The presence of the parasite was at first shown by lameness, then by an abscess, recovery following extraction of the Worm.

In Fleming's case the Horse was ridden during the campaign in North China in 1860. It was an Australian Horse, and had been for some time in India before accompanying the expedition to China; and as the symptoms did not appear until the summer of 1861, infestation might have occurred in China, the Horse having left India a year previously. A swelling formed outside the left hock, at the head of the metatarsal bone, and there was considerable pain and swelling. As it was supposed to be a contusion, fomentations were applied for some days, when one morning a Filaria, about eighteen inches long, was discovered on the litter behind the animal, and it was then found that the swelling had burst. The Horse experienced immediate relief, and was fit for duty in a day or two, the wound healing rapidly. The Worm is now in the museum of the Dick Veterinary College.

Ox.—According to Avenzoar and De Marchais, the Filaria of Medina often attacks the Ox, and the Arab physician even designates dracontiasis as the *disease of Oxen*. This is the only information we possess relative to the presence of this Nematode in the bovine species.

Etiology.—Numerous hypotheses have been framed to explain the entrance of this Filaria into the body of Man and animals. We now know, from the investigations of Fedchenko, that the embryos of this Worm find their way into the system of small soft-water Crustaceans (Copepoda), and there undergo their larval stage of existence; there may be as many as a dozen parasites in the body of a single Cyclops, without its appearing to suffer any inconvenience. It is very probable, therefore, that in drinking non-filtered water containing these Crustaceans, Man and animals become infested.

The Cyclops, by reason of its small size, may easily pass unperceived, and on arriving in the digestive canal, it would be destroyed, and the Filariæ set at liberty.

We are reduced to suppositions in following their development. Fedchenko has failed in his attempts to infest young Dogs and a Cat, by giving them milk and water containing Cyclops, in which were the larvæ of the Filaria. It may be admitted that the Worm is at first a hermaphrodite, and only becomes exclusively female in consequence of the extreme development of its uterus—full of ova and embryos; but it is very likely that the larvæ arrive at sexual maturity in the intestine of Man, the Dog, and the Horse, and copulate there. Then the male dies and is evacuated with the fæces, while the female passes through the intestinal wall, to find lodgment in some congenial situation. In a period varying from eight months to two years, it reaches its full growth, and makes its appearance under the skin.

Treatment.—The sole object of treatment is the extraction of the Filaria. With regard to Man, the method generally followed from the earliest times consists in getting hold of the Worm, either by incision or through the opening it makes, and rolling it gradually

round a bit of wood, or on a roll of diachylon. If extraction cannot be effected at once, without risk of breaking the Worm, then several days may be necessary, the wood being attached to the part by means of a bandage. Clarkson and Burke have in this way operated on Horses that came under their notice. In India the bruised leaves of the plant *Amarpattee*, or *Radpana*, are applied as a specific.

But these methods are not always practicable with the Dog. It is easier and more convenient to incise the skin for the entire length of the swelling, and at once enucleate the coiled-up parasitic mass. If the Worm happens to be extended in the form of a subcutaneous knotted cord, it can be removed at different times by repeated incisions.

ARTICLE IV.—**Indigenous Cutaneous Filariasis of the Dog.**

Rivolta has published an instance of herpetic disease in a Dog, due to the embryos of a Filaria. This Dog had at the upper part of its neck, on one side only, a moist ulcero-pustular patch, about 4 cm. in diameter, and of a dark-red colour. The few hairs remaining were erect, and matted together by crusts. Pressure caused a purulent matter, mixed with blood, to exude from this surface; this fluid, on microscopical examination, was found to contain the embryos of Nematodes, the tail of which executed very energetic movements. These embryos were also very numerous under the crusts and in the pustules. The hairs had been partly detached from their follicles.

The embryos had an orbicular mouth; the body was a little attenuated in front and very tapering behind, where it formed an exceedingly slender tail. They resembled those Ercolani found in the Horse, but were smaller. Rivolta considered them, without plausible reason, to be the embryos of *Filaria Medinensis*. This affection, which did not affect the general health of the Dog, yielded to four or five applications of mercurial ointment.

Siedamgrotzky has also published a case of dermatosis in the Dog, caused by Nematodes. The animal had, on the outer surface of all its legs, small discrete pustules surrounded by a red circle, and also small red papules, between which the hairs had been partly removed by rubbing. The pruritus was intense. In the pus from each pustule were found one, two, or three Nematodes, measuring ·4 mm. to ·7 mm. long and 10 μ to 25 μ maximum breadth. The anterior end of the body was slightly attenuated; the posterior extremity tapered into an acuminated tail, 50 μ to 80 μ long. The skin was very delicately striated. The mouth was surrounded by six indistinct lips, and was succeeded by a cylindrical œsophagus; stomach muscular and rounded; intestine simple; anus a little in front of the caudal point. The absence of genital organs was evidence that these were embryos.

The Dog did not pass any worms, either before or after the administration of the anthelmintic. In the dust of the kennel, parasites similar to the preceding, but smaller and dried up, were found, as well as some females, also desiccated. The latter differed from the embryos in their dimensions—length ·8 mm. to 1·2 mm., maximum breadth 70 μ—by their short acuminated tail, by the presence of a vulva situated a little behind the middle of the body, and about 15 oval eggs 37 μ long and 25 μ broad, containing undivided protoplasm.

By simple cleanliness, the affection disappeared in about three weeks. The kennel was thoroughly cleansed and provided with new litter.

Siedamgrotzky, in classing these Worms with Anguillulæ (Strongyloides) cites the observations of Möller of Berlin, who met with the latter on the skin of different mangy Dogs, and on one occasion when there were no acari. The skin was thickened, depilated, and the seat of an abundant desquama-

tion. Möller could not assure himself whether the eruption was caused by the Anguillulæ or whether the worms were merely commensals living on the pathological secretions of the skin. Observations analogous to the preceding have been published by Zurn, Schneider, Rosso, and Mazzanti.

ARTICLE V.—**Verminous Foot-rot of Sheep.**

Prümers has described a contagious disease which prevailed among Sheep in the circles of Wetzlar, Coblentz, Simern, and Wissenheim, and which several veterinary surgeons mistook for 'foot-rot' (*piétin*). According to him, it differed from that affection in being seated on the plantar surface, less frequently on the inner surface of the claws; while foot-rot occupies the interungual cleft and the coronet, and is accompanied by a serous discharge. Besides, this 'contagious foot-rot' (*anstekende Klauenfäule*) is manifested by dark-brown spots, 2 mm. to 3 mm. in diameter at the commencement, but in about ten or twelve days are the size of a 50-centime piece; the superficial horny layers are destroyed, and decomposition continues its perforating progress. It usually remains localized on the sole, but it sometimes extends to the fleshy parts and produces ulcerations.

A microscopical examination of the diseased horn discovered Nematodes, the mouth of which was horseshoe-shaped, and the caudal extremity was very acute; the males were smaller than the females. These details, however, are too summary to allow the genus of this parasite to be determined.

This affection is more frequent with Sheep kept in sheepfolds, than on pasture. It is contagious, probably by means of the litter. Lambs two or three days old may be attacked, when they remain with the ewes in the folds.

It has yet to be decided whether these Worms are merely commensals attracted from the litter by the horn already softened under the influence of a pathological condition of different origin.

CHAPTER VII

DERMATOMYCOSES

THE *Dermatomycoses* (from δέρμα, skin; μύχης, fungus), *Dermophytes* (from δέρμα, skin, and φυτὸν, vegetable), or, better, *Epidermophytes*, are more often designated by the name of Tineæ. They are due to inferior Fungi called *Epiphytes*, *Ectophytes*, or *Dermatophytes*, which many mycologists group into one family—the *Trichophyta*.

The *Trichophyta* are generally included in the order Hyphomycetes or *Mucedinæ*—commonly known as *moulds*. These lower fungi, consisting of simple filaments, are reproduced by means of bud-like growths, called *conidia*, which are developed on the filaments. Careful researches have, however, proved that certain of the Mucedinæ are only lower or conidian forms of more highly organized fungi, and it is possible this may be the case with all the Hyphomycetes.

In the case of the Dermatophytes a comparative study of the genera which are typical of the family Gymnoascea (of the order Ascomycetes) has caused Matruchot and Dassonville to include the ectophytic fungi of animals in this family. It must be stated, however, against this view that the formation of asci (characteristic of the Ascomycetes) has only been observed in one species of Dermatophyte—the *Eidamella spinosa* of the Dog.

The Ascomycetes are distinguished from the other orders of fungi, first, by the possession of a segmented thallus or mycelium; second, by the formation of spores in the interior of a specialized cell called an *Ascus*.

Of this order, the family Gymnoascea is characterized (1) by the situation of the asci which are enclosed in a cavity (the *perithecium*); (2) by the shape and structure of the perithecium, which is more or less spherical and made up of entwined filaments, and never a true membrane.

The Dermatophytes are reproduced by the vegetation of their mycelium, and by spores. The characteristic mode of growth of the thallus causes it to form circles more or less regular on the surface of the skin, and sometimes crusts in the form of cups.

In the parasitic state a Dermatophyte is made up of the filaments

of the mycelium, a series of tubes each limited by an amorphous envelope and containing protoplasm, more or less granular. Sometimes the protoplasm is undivided and the whole of the tubes form the vegetative part or thallus of the fungus; the cells are much longer than they are broad. In other cases the cells are as long as they are broad, and represent the so-called *mycelian spores*. These spores, separated from one another, become rounder, and in germinating, contribute to the multiplication of the parasite.

In cultures spores are formed by lateral budding; these are more characteristic of the species, and are called Conidia. Conidia are also sometimes found in the parasitic state.

But when the development of the parasite is followed, it is recognised that the distinction between these elements depends upon the phase in evolution at which they are observed. In fact, as F. Balzer has said, 'All are derived from the spore; in becoming elongated and developed, it forms a *tube* or *filament of mycelium*, in the interior of which the substance of the nucleus or protoplasm buds, sending out lateral prolongations and segments in such a manner as to constitute the *sporiferous tube*; and when at last the segmentation of the sheath takes place, in enclosing the segments of the central substance, *new spores* are formed and evolved in their turn, in the same manner. In fine, evolution begins and ends with the spore.' This is clearly indicated in the following illustration:

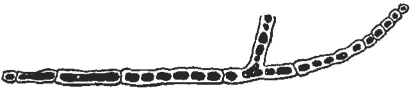

FIG. 113.—Diagram of the Vegetation of the Dermatophytes.—F. Balzer.

It should not be concluded, from what has been stated, that each tube must undergo sporular segmentation throughout its whole extent; for this only occurs at the extremities, and many of the tubes remain sterile and wither, whether or not their segmentation has been commenced.

The discovery of the parasitic nature of Ringworm was made in 1839, when Schönlein observed that *tinea favosa* or favus of Man was caused by a fungus—of which Gruby published a good description in 1841, and to which Leberte in 1845 gave the name *Oidium Schönleinii*. Shortly afterwards Gruby discovered a *Trichophyton* in *mentagra* (1842), then a *Microsporum* in 'la tondante rebelle' (1843).

The Dermatomycoses of the domesticated animals have for a long time been known under the common name of *dartres*. In 1852 the parasitic nature of the *dartres* of the Horse was first suspected as a result of the occurrence of contagion to Man. The following year Bazin demonstrated the existence of *Trichophyton tonsurans* in 'la dartre tondante' of a Horse which had infected the gendarme

in charge of it. A few years later (1857) Gerlach published an important work, in which he clearly showed the parasitic nature of dartre of the Ox. About the same time Reynal read before the Academie de Médicine of Paris a memoir containing evidence of the transmission to Man of the dartres of the Horse and Ox, and of the identity of these conditions with *Herpes tonsurans* of Man. From that time the study of the Dermatomycoses became more exact. Gradually the field became wider and the number of parasitic species increased. Reaction, however, was not long in coming. In 1850 Lowe sought to establish that all the vegetable parasites which grow on man are identical, more especially the *Achorion* of favus and the *Trichophyton* of *Tinea tonsurans*, and that they are only lower forms of the same mould (*Aspergillus glaucus*). Hogg, in 1859, expressed the same opinion, and was supported by Tilbury Fox and by Hebra. Hebra based his opinion on the phenomena produced on the skin of Man by the application of compresses covered with moulds. At the time Tulasne had discovered the pleimorphism—or polymorphism—of certain Fungi; the observations of De Bary, Hoffmann, and Kühn had confirmed this fact, and it was natural that it should be sought to apply the knowledge thus acquired to the Dermatophytes. Hallier was the most ardent promoter of this generalization of the facts of polymorphism; but the experiments invoked in support of his theory have been considered by the most distinguished botanists as stained with errors.

Later, and with momentary success, Grawitz held analogous views, and considered the Fungi of *Tinea tonsurans*, *favus*, *pityriasis versicolor*, and *thrush* as identical with *Oidium lactis*. All culture experiments, however, and especially those of Duclaux (1886), have proved the impossibility of transforming any dermatophyte into *Oidium lactis* or reciprocally. The mistake of Grawitz, which he acknowledged later, can be explained by the variations in shape that the dermatophytes may undergo according to the conditions of cultivation. Now, clinical experience and mycology agree in denying any identity of action or nature between a dermatophyte and a mould.

This does not mean that the parasitic life is absolutely necessary to the dermatophytes. It is possible that some of them have a saprophytic origin—that is, they may exist naturally on vegetable or inert matter, where they are developed and reproduced, and that animals become contaminated by contact with such inert or vegetable matter. This has been proved for internal mycoses such as actinomycosis and aspergillosis, and there is no reason to consider it impossible for the dermatomycoses.

With regard to the question of the specific autonomy of the Dermatophytes, dermatologists, in the last ten or fifteen years, have shown a tendency just the reverse of that caused at first by the discovery of the parasitic Fungi of Ringworm. The application of culture methods has led many experimenters to subdivide the

old species, and to recognise nearly as many clinical varieties. These efforts have chiefly been applied to *Trichophyton* and *Achorion*, and they seem justified by the results of cultures. But many of the new species have already been recognised as illegitimate, and it may be that several of the others represent only varieties of the type species, to which they may return after a sufficient series of cultures. The formation of different pigments, on which current classification is mainly based, does not appear to be sufficiently settled to serve as a criterion, and we shall only retain here the species whose legitimacy has not yet been seriously contested.

It should be noted, also, that certain genera, such as *Achorion*, *Microsporum*, and *Trichophyton*, are connected by intermediate forms which indicate their relationship.

The Dermatophytes of the domesticated animals belong to six distinct genera—*Trichophyton*, *Eidamella*, *Microsporum*, *Achorion*, *Lophophyton* and *Oospora*. The essential characteristics of these genera are furnished by their cultures, but notwithstanding the necessity of cultures for the scientific determination of a dermaphytic Fungus, we shall limit our remarks to those characters of the genera that may be traced by microscopic observation *in situ*, in the lesions, in the parasitic life of the dermatophyte.

1. **Trichophyton** (Malmsten, 1848).—Mycelium, with simple or dichotomously branching filaments, much segmented, and producing spores in their interior (mycelial spores); diameter 4 to 9 μ.

A special characteristic of the Trichophytons consists, according to Sabouraud, in the position of the Fungus with regard to the invaded hair. The *Tr. endothrix* lives inside the hair; the *Tr. ectothrix* lives outside the hair, which it surrounds like a sheath; and the *Tr. endo-ectothrix* develops both inside and around the hair. The faviform Trichophytons of Bodin belong to the third group.

The division of the Trichophytons of animals into endothrix and ectothrix types does not appear to have any real value. The same Trichophyton inoculated on animals of different species, on individuals of the same species, and also at different places on the same individual may have, according to the case, the appearance of an endothrix or an ectothrix. Besides, in well-prepared sections of the lesions, very often we see that the hair is invaded through and through by the parasite, even when an examination of hairs pulled from the lesion appears to warrant the conclusion that the parasite is of the ectothrix type (Dassonville).

2. **Eidamella** (Matruchot and Dassonville, 1901).—Mycelium much branched, 1·5 μ in diameter, divided into short segments, and splitting into sub-square or oval elements. Only one species, on the Dog.

3. **Microsporum** (Gruby, 1843).—Mycelium producing lateral branches bearing conidia (conidian spores), from 2 to 3 μ in diameter.

4. **Lophophyton** (Matruchot and Dassonville, 1899).—(Epidermophyton Mégnin, 1881; not *E.* Bazin, 1862; nor *E.* Lang, 1879).—Mycelium with filaments, some tortuous with thin walls, usually sterile (without protoplasm); others short, curved, with thick walls and granular protoplasm (mycelium of conservation); no spores. Only one species, on the Fowl.

5. **Achorion** (Remak, 1845).—Mycelium, with straight or flexuous filaments, from 2 to 3 μ in diameter, formed of cells from 12 to 15 μ long, branching by dicho-, tricho-, or tetra-tomy, with a thick membrane, finally breaking up into isolated polyhedral bodies (mycelian spores).

6. **Oospora** (Wallroth, 1833).—Mycelium with filaments from 2 to 3 μ in diameter, intermingled with round or oval elements 5 to 6 μ in diameter

and arranged in long irregular chains. Affecting the Dog. (The parasite of the Dog, *O. canina*, certainly does not belong to the Gymnoascea, nor does any other species of *Oospora*.)

The Dermatophytes localize themselves on the epidermic tissue and even penetrate into the hairs and between the cells of the epidermis—separating them from each other, decomposing them, living on them ; and consequently determining by this action, and the shedding of the hair, a more or less acute degree of irritation, characterized by pruritus of varying intensity, redness of the naked skin, and also, sometimes, exudation.

Subordinate to the growth of the Fungus, the tineæ have usually a chronic course ; but the prognosis they elicit is always favourable in regard to animals, on which it is always easy to destroy, with impunity, the parasite that occasions them. They are due solely to contagion, and beyond age—for young animals appear to he most liable to them—no general conditions are known that influence their manifestation.

Contagion may be *direct*, produced by actual contact of the animals ; or *mediate* by means of grooming tools, litter, etc., and it is even possible that spores may be carried some distance in the air. According to the nature of the Fungus, contagion takes place more or less easily between animals of the same species, often between those of different species, and even from animals to Man.

The **diagnosis** is based on the most apparent clinical symptoms ; but however marked these may be, it is always useful, if not necessary, to have recourse to a microscopical examination of the altered epidermic products. This investigation should be made on the most recent—the youngest or deepest part—of the crusts that cover the circular patches of the disease, and on the hairs grown at the periphery of these parts.

On scraping the skin with a spatula, or small curette with margins a little sharp, epidermic pellicles and hairs are collected. The products that abundantly cover the patches are very poor in parasitic elements, and it is advisable to concentrate attention on the deeper parts in direct contact with the skin. To examine the hairs easily, they should be removed from the periphery of the patches by means of a pair of forceps. A direct examination can be made at once, for it is sufficient to soften the crusts and scales in water. But it is better to employ a 40 per cent. solution of caustic potash, and on warming the preparation slowly nearly to boiling the alkaline solution breaks down the epidermal cells and clears the preparation. The particle to be examined is disassociated in itself by pressure on the cover glass, which reveals the presence of the elements of the parasitic Fungus. In general, there is scarcely any need to previously remove fatty matters by treating the substance with ether or absolute alcohol. For durable preparations, there must be substituted for the alkaline solution in which the elements were first examined glycerin, or, better, carbolized water, which has not the disadvantage of rendering the preparation too transparent. Sabouraud does not advise the use of aniline stains, as they produce opaque preparations, not easily interpreted ; lactic blue has not this disadvantage, and may be used like the potash solution. A magnification of from 200 to 500 diameters is most convenient.

By the naked eye or hand lens, there can often be seen at the base of the hairs which have been pulled out, a whitish mass surrounding their root,

which is formed of the parasitic elements. If the examination be extended to the hairs that are much altered and broken, their ends will be found split up and frayed like a brush. At times there are found here and there, between the crusts and the skin, small, yellowish, earthy-looking masses, readily broken up, which are nearly exclusively formed of the Fungus in the state of spores, or more especially of filaments. But it is only by the study of all the products of the morbid process, that a complete idea can be derived as to the nature of the parasite.

Vitality of the Parasite.—Gerlach undertook some experiments to 'determine the duration of the germinative faculty of the spores. Crusts were collected in autumn, kept in paper capsules in his laboratory until the following spring, and experimented with at intervals. Those which were more than three months old had lost their potency when placed on an unprepared skin, but spores six months old—inoculation being effected by scarification—still germinated and produced perfectly developed ringworm. It was noted that, the longer the incubation period, the thinner were the crusts and more rapid the recovery. Spores more than six months old were not experimented with.' Siedamgrotzky has in vain tried to transmit tinea tonsurans from the Horse to the Goat, by means of crusts kept for five years and eight months. But he succeeded, on the caprine species, with crusts from a Bull, which had been kept eighteen months. Mégnin says he has successfully inoculated a Dog with crusts eighteen months old. In Duclaux's cultures, the Fungi which had been kept for two years would not germinate.

By a long series of experiments made with cultures of the Trichophyton in Koch's nutrient gelatin, Thin has obtained interesting results. He has found that in about two years and a half the spores seem to have lost all their aptitude to germinate, but he has been able to grow those which were eleven months old. The spores from trichophytic hairs were dead after being immersed eight days in water, but survived two days' steeping; they also preserved their germinative power after being kept forty-eight hours in olive-oil, lard, or vaseline. An hour's contact with soft soap, or a one per cent. solution of acetic acid, appeared to be sufficient to kill them; but a one per cent. solution of carbonate of soda was less efficacious, germination taking place even after three days. Sulphur ointments had a slow action upon them, and required several hours to sterilize spores. Citrine ointment was a very active destroyer, for after an hour's contact with it spores could no longer germinate; on the other hand, croton-oil was absolutely inefficacious, as after eight hours' immersion in it the Trichophyton preserved its vitality.

Cultures.—The Dermatophytes usually grow well on media with a neutral or slightly alkaline reaction and containing glucose. Sabouraud recommends the following formula:

Pure glycerin, glucose, lactose, or better maltose	4	grammes.
Granulated peptone	1	,,
Distilled water	100	,,
Gelose	1.50	,,

Agar, beer-must, potato, coagulated serum, peptonized bouillon, gelatin, or agar peptone may be used, but liquid media are less favourable than solid ones for differentiating the species. Growth takes place even at 15°, is very active at 30°, but above 36° the culture may be spoiled.

The cultures are grown in inclined tubes or in flat dishes. These cultures in dishes at the ordinary temperature are often necessary in order to observe closely certain conidian formations, since these *easily break up. Air must have free access to the cultures through* a cotton-wool plug, as the Fungi require much oxygen.

ARTICLE I.—Ringworm of the Horse and Ass.

Four species of *Trichophyton* and one of *Microsporum* have been given as causing the various forms of ringworm in the Horse. To these must be added the Verrucous Trichophyton of the Ass. The various species are :

1. **Microsporum Audouini** (Gruby).—Mycelium forming in the hair an axial bunch of parallel filaments, from 2 to 2·5 μ in diameter, divided into fairly long segments, and giving off thin branches at right angles to the filament, directed towards the surface, where they produce conidia (conidian spores). These are rounded or polyhedral by mutual pressure, smooth, shiny, from 2 to 3 μ in diameter, and crowded round the hair, which they ensheath from its root up to 3 mm. above the follicle, causing it to become greyish and brittle.

M. Audouini var. *equinum* (Delacroix and Bodin).—This variety represents the form under which the species is met with in the Horse. It is distinguished from the type by its polymorphism in cultures, in which it may take three different forms.

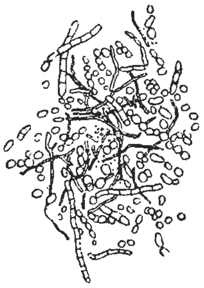

FIG. 114.—*Trichophyton* of the Horse ; magnified 500 diameters.

2. **Trichophyton mentagrophytes** (Ch. Robin ; **Tr. depilans**, Mégnin).—Pyogenic Trichophyton with white cultures (Sabouraud). The Mycelium breaks up into chaplets of spores measuring 5 to 6 μ in diameter, but of very unequal size, especially about the periphery of the hair (from 2 to 3 μ up to 10 or 11 μ). Endo-ectothrix.

3. **Trichophyton flavum** (Bodin).—Cultures yellow—friable—wormlike (Sabouraud). The Mycelium breaks up into ovoid or irregular elements, which average from 5 to 6 μ, some up to 11 μ. Endo-ectothrix.

4. **Trichophyton equinum** (Gedoelst).—The intrapilar mycelium separates into oval spores from 4 to 6 μ by 2 to 4 μ broad. Around the hair segmented branching mycelial filaments break up to some extent into spores. Endo-ectothrix.

5. **Trichophyton verrucosum** (Bodin, var. *equi*).—Faviform trichophyton with brown cultures, the growths irregular and prominent. Mycelium rapidly breaking up into spherical spores with a double outline. Endo-ectothrix.

6. **Trichophyton verrucosum** (Bodin, var. *asini*). Faviform trichophyton with grey cultures. Mycelium breaking up into regular chainlets of round elements. Ectothrix.

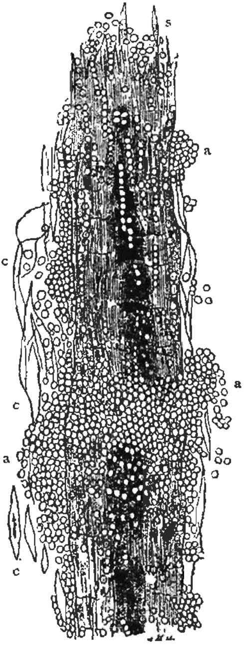

FIG. 115.—Horse's tail invaded by the *Trichophyton*; magnified 350 diameters.

a, mass of exterior spores; *s*, split summit of the hair; *c*, cells of the epidermis of the hair.

Symptoms.—In the Horse it is necessary to distinguish two different kinds of Ringworm — Microsporosis and the Trichophytoses.

1. MICROSPOROSIS.—This affection corresponds to the disease known under the name of 'Contagious Herpes of Foals,' and it almost exclusively attacks young Horses. It appears in patches which are more especially seated on the upper part of the body—on the shoulders, back, loins, croup, sides, and flanks — where, in fact, the grooming instruments most readily carry the parasites, in the dissemination of which they are the most active agents. These patches may, however, be met with on any part of the body, though they are rare on the lower parts of the legs.

However much care may be taken — even in experiments closely watched from the evolution of the malady—the abundance of hair and the pigmentation of the skin are most frequently opposed in an absolute manner to observation of the primary phenomena of the eruption. What are first noticed are the circular patches, the diameter of which is generally about that of a shilling; they are distinguished from the healthy skin by the dulness and erectness of the hairs covering them. Some time before the circular patches appear, a very small tuft of hairs — probably from half a dozen to a dozen—may be seen slightly but markedly raised in the form of a fine pencil, and feeling as if they had a somewhat hard base, or were matted together at the bottom, when the finger is passed over them These tufts may be several in number, and are usually best seen on the hind quarters at the very commencement

of the disease, or in the vicinity of the patches, of which they are the initial symptom.

The hairs fall off in a few days, and this is often the first symptom that attracts attention. Mégnin remarks that this phenomenon is precipitated by grooming, and that, as the hairs at the periphery are the first to fall, this is the cause of the formation of rings in tinea tonsurans—an aspect that must not be confounded with the herpes circinatus of Man, which is due to another phenomenon. But this feature soon passes away, and it is not long before the whole surface of the patch is depilated; and if the malady extends, the coat of the animal acquires, through these nummulary spots, a quite peculiar appearance The hairs do not fall by avulsion, but by breaking across, almost on the surface of the skin, and it is readily noticed that the broken end is irregular, and as if frayed, like a brush.

The epidermis of the patch falls off at the same time as the hairs; it appears to be softened, and the surface of the skin has then a dark-grey tint and is slightly moist, which might be attributed to the rupture of vesicles, though their presence has never been demonstrated. It cannot, therefore, be said, as Railliet remarks, that the disease presents itself in the form of *herpes*, as what is so called in human pathology includes a phase marked by the appearance of vesicles.

The humidity of the patch is ephemeral. Its surface generally soon dries, and is covered with epidermic scales of varying thickness, which are agglutinated into flat crusts that are shed and renewed incessantly These crusts have—more frequently than in the Ox—a shining appearance and a grey or yellowish colour like flax. At the same time, the lesion progresses by peripheral extension until it attains the diameter of a five-shilling piece or more, and on each zone invaded the following successive symptoms are observed. On gaining these dimensions, the patch ceases to extend and the crusts to form, and there remains a dry, glabrous, harsh surface of a greyish slate colour, throwing off some furfuraceous scales, from which the hairs grow slowly, and are of a darker colour than the other hairs, except in light-grey horses.

This is only a local recovery, as patches are formed more or less near the preceding, to run through the same phases; and it is possible that confluent patches may unite to constitute a vast ringworm surface, the cure of which is more difficult to effect (Railliet).

We have remarked on the extreme abundance of the Fungus, in powder and crusts collected by Couzin on a mule from Gaudeloupe, the skin of which—and especially that of the legs—was almost completely hairless. The commencement of this kind of alopecia did not date for more than two months.

Fleming has met with a circinated variety, which might be allied to the circinated trichophyton of Man, by its form and mode of growth; it being simply due to the cure of the central portion

of the patch while the disease extended at the periphery. The lesion thus appeared as a more or less complete ring.

Pruritus is nearly absent in Microsporosis, and is scarcely even shown to exist, except by movements indicating satisfaction on the part of the animal when the patches are gently scratched.

A variety of Tinea quite different from the preceding in its clinical characters has been observed by Le Calvé and Malherbe. From it they obtained a parasite which Bodin has recognised as specifically identical with the Microsporon of the Herpes of Foals, but differing from it by the property of giving directly in cultures the form *Oospora*.

This form of Microsporosis was manifested by hairless patches, which during several years had made their reappearance in the spring and readily disappeared in the interval under the influence of simple treatment. The patches were numerous, round, with a well-defined contour, regular, measuring 7 to 20 mm. in diameter, glabrous, without epidermal proliferation and not pruriginous. They were found all over the body, but especially on the limbs. On some parts the surface was covered by slightly adherent greyish, crusts carrying broken hairs. On the patches the hairs were broken away close to the skin, whilst at the margin they were whole, but tapered and twisted or bent, and still rather adherent. Along the hairs, and particularly on the fragments, were yellowish masses which, under the microscope, proved to be spores of Microsporon. They were still more distinct on the scales.

2. **Trichophytoses. A.**—*Trichophyton flavum.*—The lesions consist of large patches, at least 8 to 10 cm. broad, of a more or less regular form, greyish, and quite smooth. The hairs, raised and matted at their base by a greyish yellow crust, fall away very rapidly with the crust. The naked surface is not prominent, and shows no trace of suppurative folliculitis (Bodin).

B. *Trichophyton equinum* occurs usually in numerous patches, some isolated, scattered over the croup and shoulders, and attaining at the most 3 cm. in diameter ; others confluent, generally crowded on the back, and from 4 to 5 cm. in diameter. At first they can be detected only by touch, but later they become visible by the flattening of the hair. The least traction or slight friction carries off a scaly crust which brings away the diseased hairs. The skin then appears smooth, moist, pinkish, or light grey. Very soon the patch becomes dry, scaly, or powdery, and its base a slaty grey. The lesions spread by the falling out of the marginal hairs (Matruchot and Dassonville).

C. *Trichophyton verrucosum*, var. *equi*, occurs in numerous patches which average 5 to 6 cm. in diameter, and are localized on the shoulders, neck, withers, flanks, in fact, everywhere where the harness touches. By their confluence these patches may produce large, irregular lesions. At first the hairs are raised, not broken, and are matted together at the base by a soft grey crust. This crust falls off in less than a week, carrying away the hairs, and

leaving an absolutely bald, grey surface covered more or less with dry, greyish scales, and without follicular suppuration. In young Horses, however, the shedding of the crust leaves a vesicle or pustule, then the surface of the patch is slightly raised, red and indurated (Bodin).

D. *Trichophyton verrucosum*, var. *asini*.—The lesions are the same as in the preceding Trichophytosis of the Horse, but are generally confined to the neck, head and ears (Bodin).

E. *Trichophyton mentagrophytes.*—This Trichophytosis occurs usually on the nostrils or head. It forms patches up to 5 or 6 cm. in diameter, which may be mistaken for pustules of horse-pox undergoing regression. Over the whole of these patches the hairs are matted together at their base by a soft, brownish crust of unequal thickness. Slight traction on the hair brings away the crust, exposing a bare, slightly raised surface, which is red, inflamed, and pitted with small depressions, grey at their base. These result from the opening of fine pustules, of which some may be found at the margin of the patch. The hairs are not broken, but shed, and the condition is, in fact, a suppurating folliculitis.

The course of the disease is rapid, and four to five weeks are generally sufficient for its cure. This is the form mentioned by Mégnin. It has been studied by Viseux, by Delamotte and Bogenez and by Everard. It may, in certain cases, be developed with remarkable rapidity. A Horse which appeared to have nothing amiss with it at night, was found next day to have five hundred patches on its body (Everard). Mégnin has reported a contagious dermatosis met with by Weber, which consisted of papules about a centimetre in diameter, covered by a crust that was easily detached by scratching it, leaving a dark-grey denuded surface, somewhat granulating, which at a distance looked like the cicatrix of a small-pox pustule.

Course, Duration, Termination, Prognosis.—In general, the *affected patch is limited by a maximum of diameter which it only* exceptionally exceeds. When it attains this maximum it spontaneously disappears, the fungus having expended its local activity. But the animal is not cured, as the various rubbings have carried the spores to other points, where they form patches that run the same course. If these are near each other they may join, and it is this junction which constitutes the large diseased surfaces that are sometimes seen. Nevertheless, this extension of the disease is not indefinite. It gradually diminishes, and the malady may in the end vanish without medical interference.

The average duration of Ringworm is from forty to fifty days; though circumstances which favour the appearance of the malady may also prolong its existence, and this is the reason why it is more tenacious in young animals. Absence of cleanliness is also more efficacious in this direction, as it facilitates the multiplication of ringworm patches; and indefinitely prolongs the duration of the affection. Recovery takes place sooner in animals which

have a fine coat or are clipped, and are well fed and cleaned, than on those which have a long thick coat, and which are also badly attended to. Shedding the coat expedites recovery, and this explains the influence of spring-time on animals at pasture.

It is scarcely probable that 'issues' have the salutary effect on this affection that Reynal attributed to them, as he did also to 'strangles'; though with regard to the latter it is not so improbable, but it needs verification. In any case, the malady is generally easily cured, and in this respect it is very different from the tinea tonsurans of Man.

When recovery has been effected, the hair grows again, and at once the diseased patches can be distinguished from those which are cured, and which have no crusts or scales, nor broken, brush-like hairs. Afterwards, and for some time, the formerly affected parts can be recognised in the coat, by the hairs covering them being very fine and darker in colour.

The Tineæ of the Horse are benign affections which do not disturb the general health, nor resist curative measures; indeed, they may disappear of themselves. The general symptoms which several authors have described, were only a coincidence, and belonged to an antecedent pathological state—languor, inappetence, debility, and marasmus—that prepared the soil for the evolution of the parasite.

The contagious properties of Ringworm are its most serious feature. It may extend to all the animals on a farm, in a stable, or in a regiment, and—what is very important, because of the more malignant character it assumes—also to the people who attend to these; this circumstance renders prompt treatment necessary.

Diagnosis.—The various tineæ of the horse are very difficult if not impossible to distinguish from one another by a clinical examination. The form due to *Trichophyton mentagrophytes* is easily recognised by the symptoms of follicular suppuration which it causes. For the rest they all produce bare circular patches from which the hairs have fallen along with the crusts which hold them together at their base, and diagnosis of the parasite can only be established by means of cultures entrusted to a competent mycologist. Still it is possible that later studies may destroy the autonomy of several species of the Trichophytons of the Horse.

The parasitic nature of tinea tonsurans should always differentiate it, after a microscopical examination, from all other cutaneous affections exhibiting clinical signs that might at first sight cause a mistake to be made. Besides, the circular form of the patches and the appearance of their surface, and especially that of the hairs, as well as the contagious properties of the malady and the other points insisted on above, should prevent any error being committed.

Mégnin has described a *circinated psoriasis* in the Horse, of a herpetic nature, which might be mistaken for tinea tonsurans. But it is distinguished by the absence of any parasite, by the hairs not being altered—they being shed entire—and by the resistance of

this affection to all anti-parasitic treatment, but quickly yielding to the internal administration of iodide of potassium.

The *strangles herpes*, which is accompanied by a viscid secretion that agglutinates the hairs on round or oval surfaces, in three or four days brings about the depilation of these, though they are not long before they are re-covered by fine and abundant hairs. This entirely different course, with the absence of the parasite, constitutes a sufficient criterion.

Etiology.—The efficient cause of Ringworm is the parasite, from which it is inseparable, though certain conditions favour its development and transmission.

PREDISPOSING CAUSES.—This malady, as with so many others, was attributed to various debilitating causes before its true nature was discovered. It was imagined that weakly, worn-out animals were more liable to it than others; but it can now be only admitted that, at the most, they afford a more favourable medium for the parasite. The influence of uncleanliness and want of attention is better defined. Animals badly cleaned and attended to are most frequently attacked, and it is usually to negligence that must be attributed the greater frequency of the affection in certain countries. Early age is a predisposing factor. Foals still sucking are not exempt, and young Horses collected for army purposes are specially liable. (Normandy has a reputation for sending many horses with Ringworm to the French remount depots.) Ringworm in Horses is rare in Australia, although the reverse is true for Cattle (Fleming). Ringworm appears sometimes as an epizoötic; in 1840 it was seen on several hundred Horses in the Borne Valley in Savoy. Cavalry regiments sometimes show similar examples.

Contagion.—I. *From Horse to Horse.*—The first example of this method of infection appears to have been observed by Bouley the younger, in 1852. The case was that of a young Horse belonging to the gendarmerie, which arrived at the remount depot at Caen with a tonsurans patch on its body, and communicated its cutaneous affection first to its neighbour, then successively to seven Horses in the same stable. Two of these, sent to the Alfort Veterinary School, conveyed the malady to other two Horses, their neighbours. The agents in this contagion were the curry-combs, brushes, wisps, and clothing which had been used on the affected animals. This mode of contagion is often witnessed in regiments. It may also take place by means of the working harness, and especially by the saddle. Mégnin, in 1882, published an instance in which the part played by the saddle was remarkable. About two hundred horses of his regiment had been successively affected with tiuea, and in the first cases the patches occupied the seat of the saddle on the left side of the back. This was owing to the lesion on the first Horse attacked being located there, and the saddle having been successively worn on several other Horses, so that each of these had the spores of the Trichophyton sown on their skins at the same point. We possess other instances of similar epizoötics observed in

regiments of cavalry. Lastly, the clippers, scissors, and grooming tools may be important factors in spreading the disease.

II. *From other Animals to the Horse, and Inversely.*—Gerlach succeeded in transmitting tinea from the *Ox* to the *Horse*. 'In about eight or ten days the traces of the contagion were undoubted, and a circular patch, with sharp outline, was established in the course of the third week; but towards the fourth or fifth week it had disappeared, leaving behind it a smooth, denuded surface. The crust was not so thick as in the bovine animal, and only contained a few Fungi between the scales; the hairs did not break. In 1878, Mégnin also obtained transmission of tinea from a calf to a Horse.

In 1852 Reynal experimentally transmitted tinea tonsurans from the *Horse* to two *calves*, in cleaning them by means of the curry-combs, brushes, and wisps used on the two Horses already mentioned; and Nettleship has remarked on analogous instances.

Siedamgrotzky has successfully inoculated the tinea of the *Horse* on a *Dog*, two *Sheep*, and two *Pigs*.

The ease with which one is able to transmit Ringworm from the Horse to the Ox, and reciprocally, is due to the fact that one of the most frequent dermatophytes of the Horse—*Trichophyton mentagrophytes*—is also the common form in the Ox. The *Microsporum* of the Horse is easily inoculated on the Guinea-pig (Bodin), and on the Dog (Le Calvé and Malherbe). It is, besides, met with in one of the tineæ of the carnivora.

III. *From the Horse to Man.*—Zürn states that transmission of the malady from the Horse to Man was first, and on several occasions, observed by Papa in 1848, during an epizoöty of tinea tonsurans that prevailed among Horses in the valley of Borne, Savoy. But the first detailed observation dates no further back than 1852; it is due to Bouley the younger and Reynal, and the occasion was that already mentioned. The *gendarmes* who groomed the Horses alluded to contracted the disease with which they were affected, and one of these men communicated it to his wife and daughter. The two Horses sent to Alfort also infected a student and the man who looked after them. Bazin recognised in the malady the animal origin of herpes circinatus. Some years afterwards, Galligo published the case of a coachman who contracted the disease from his Horse.

These facts remained for a long time isolated. But from 1871 they became multiplied. In that year Tilbury Fox communicated to the Clinical Society of London a case of transmission of herpes circinatus or 'ringworm' from a pony to seven people. Then G. Fleming, T. Fox, and Horand made known new instances. In 1876, Dr. Dieu published an account of an epidemic of herpes circinatus, communicated from the Horse to Man in his regiment; in eight months, twenty-two soldiers were successively contaminated by young Horses which had recently arrived from the remount depot at Caen. Larger saw about one-fifth of the effective men in

a regiment of dragoons attacked by herpes circinatus of equine origin. Similar facts are indicated by Mégnin, Aureggio, and Touvé; Gerlier, and Longuet, who has given an excellent tableau of this question.

The infection of Man, however, is exceptional, when the frequency of tinea tonsurans in the Horse is considered, as there is scarcely a regiment in which it is not present always, on some young Horses.

Grooming is the usual means by which the disease is conveyed, and it is to this that nearly all the cases of transmission are attributed. Sometimes it is the horse-clothing, borrowed from the Horses by the men, that conveys the Fungus (Mégnin). The trichophytic epidemic at Ferney-Voltaire, described by Gerlier, began among the children of a horse-clipper, who had cut their hair with his clipping-machine.

The rubbings that accompany grooming facilitate inoculation. The principal seat of the eruption is the fore-arm and the wrist—that is, the two parts of the arm usually uncovered during this operation. In Mégnin's report, it was on the face and neck that the eruption appeared on the men who had made use of the rugs worn by Horses affected with trichophytosis. The period of incubation varied from five to ten days.

Trichophytosis here attacks by preference the smooth parts, and presents itself—as in that of bovine origin—in the form of tinea circinatus, which is also remarkable for the particular intensity of the symptoms. Often, in fact, it is quite equal in this respect to the disease conveyed from the Ox. Gerlier has, however, established distinct differential characteristics between the human trichophytosis of bovine origin, and that derived from equines, which he was able to study comparatively—the first being very frequent in the valley of Gex, where he practised. The Trichophyton of the Cow causes a true, inflammatory sycosis, passing into a furuncle, and even to a carbuncle; a spontaneous recovery is frequent, but it is followed by a cicatrix; and this parasite appears to be incapable of producing trichophytosis of the scalp. It is the opposite with the Trichophyton of the Horse, which has a greater tendency to acclimatize itself on Man, is more epidermic, and more intractable to treatment.

These facts preceded the discovery of the plurality of the Dermatophytes of the Horse. We now know that the various species are not equally contagious to man, and that they produce very different lesions. The *Microsporum* of the Horse causes, on the smooth skin, small transient erythematous lesions resembling circinate trichophytosis at its acme, and disappearing spontaneously or under very simple treatment (Bodin). A lesion of a peladoid type of the scalp in children has, however, been referred to this equine parasite (Bosellini).

In an epidemic of Ringworm due to the *Trichophyton equinum* several men in charge of the Horses showed lesions in the form of patches chiefly on the neck. Experimental inoculation produced a similar patch on a man's arm (Matruchot and Dassonville). As in the Horse, the *Tr. mentagrophytes* produces in man an expulsive suppurating folliculitis. On the smooth skin it is an agminated folliculitis, on the chin a sycosis, and on the scalp a Kerion of Celsus. These affections readily yield to treatment.

Trichophyton flavum is very contagious to Man, producing lesions

analagous to those it causes in the Horse ; it is a simple dermatitis, in more or less extensive patches slightly moist, and not intractable (Sabouraud).

Trichophyton verrucosum, var. *equi*, also very contagious to Man, induces expulsive follicular suppuration which occupies a surface raised like a cupola (Bodin).

Trichophyton verrucosum, var. *asini*, is also capable of affecting Man. The follicular suppuration which it causes is not manifested by raised patches as in Kerion, but as red, scarcely salient surfaces with some whitish vesico-pustules. W. Williams has recorded the transmission of *Tinea favosa* to three Horses and twenty cattle in the same stable from affected Cats which were accustomed to sit on the animals' backs. This was doubtless trichophytosis of the Cat caused by *Trichophyton felineum*.

Treatment.—The prophylaxis of Ringworm consists in attending to the cleanliness of the animals, and in careful and regular grooming. It requires the disinfection of stables inhabited by affected Horses, of grooming tools and harness, if these are likely to be employed on others.

With regard to curative treatment, should the malady be very limited, its extension is to be prevented by keeping the currycomb, brush, and wisp off the diseased patches, as these articles carry the spores to other parts of the body. Mégnin reports having radically cured many young Horses, by merely having the crust gently scraped off entire, along with the broken hairs, these being immediately burned.

In some cases it is advisable to resort to general clipping, as a preliminary to treatment ; and it may be again suggested that all grooming should be done out-of-doors.

With regard to the medicaments to be employed, nearly all give favourable results, the growth of the parasite on the domesticated animals being readily disturbed or suspended by medicamentous applications. The simplest are to be preferred, and those which cause much irritation are to be avoided as they may leave durable, if not indelible, traces on the skin. Tabourin has given a fastidious enumeration of a very large number of agents that may be used for Ringworm on animals. The most popular remedies are : a solution of corrosive sublimate, 1 to 500, and slightly alcoholized ; carbolized glycerin, tincture of balsam of Peru ; pure alcohol ; petroleum ; cade-oil ; white precipitate ointment ; red precipitate ; ægyptiac ; an ointment composed of carbolic acid 1 part, and lard and soft soap, of each 20 parts ; Helmerich's pomade ; and tincture of iodine.

Pure soft soap, applied as an ointment, is, according to Thin's experiments, to be recommended.

The applications are to be repeated once or twice a day, or every second day, the frequency depending upon the agent selected, and its local irritant action. Fleming found one application of a liniment composed of one part Stockholm tar, and two parts common oil, a cheap and effective remedy for ringworm on Horses.

Fourie and Le Calvé recommend Cutler's prescription which consists of pure carbolic acid, tincture of iodine, and chloral hydrate in equal parts. The hair is clipped, the affected part washed with soap and water, and then painted with the preparation. A cure is obtained when the surface of the patch is covered by a new growth of fine, close-set hairs.

ARTICLE II.—**Ringworm of the Ox.**

The Tinea of the Ox has long been known, at least in its clinical aspect, if not more exactly. The peasantry of Auvergne name it *anders* or *indères* (Grognier), those of Limousin *anders* or *endai* (Lemaistre), those of Poitou *anderses* (Gellé), and those of the South of France *teigne* (Carrère), *brillants* (Rigal), or *sous-brillants* (Houlès).

Its parasitic nature was proved in 1857 by Gerlach and by Reynal. It is always a Trichophytosis, and the common form is due to *Trichophyton mentagrophytes* (Ch. Robin ; see p. 245).

On two calves affected with *Tinea tonsurans* of a distinctly Trichophytic character Bodin found an endo-ectothrix Trichophyton, with large irregular spores forming flexuous chaplets, which, by cultures, came nearer the favus group than that of Trichophytosis. It is a variety of *Trichophyton verrucosum* analogous to those of the Horse and Ass, and produces a 'favus with Trichophytoid lesions' (Bodin).

Galli-Vabrio has connected with *Trichophyton Sabouraudi* (R. Blanchard), which is responsible for 30 per cent. of the cases of 'tondante' in children, an endothrix Trichophyton which he found on a Calf attacked by tinea with dry white lesions.

It is not impossible that these three parasitic forms may yet be found to belong to one and the same species.

Symptoms.—In the Bovine species, in which the disease appears more frequently than in any other, it is rarely disseminated over the whole surface of the skin, but prefers locating itself on the lips of Calves, on the head, neck, upper parts of the body, and altogether *exceptionally on the inferior regions of the limbs.*

The commencement is manifested by a slightly salient ring, on the surface of which the hairs are erect. An active proliferation of the epidermis causes the rapid formation of scales more or less adherent to each other, and crusts of 2 mm. to 7 mm. thick —hence the name *dartre crouteuse* given to the affection by the older (French) veterinarians. According to Gerlach, the crusts are thicker on dark skins, on which they have a greyish-white, fibrous appearance, resembling the amianthus (*porrigo asbestinea*) ; on white skins, which are usually finer, the crust is thinner and a little yellow in colour.

The lesion progresses by a regular centrifugal radiation ; other patches form, those which are nearest to each other becoming fused into a larger one, and their diameter varies in this way from the size of a florin to that of a five-shilling piece. Gerlach states that they may even be as large as a plate. The dark hairs break off at the

surface of the crust, and the patches then become more apparent; but the white hairs rarely do so, for a certain numberof them always persist, and they surmount the crust in such a manner that white skins never appear to be tonsured.

At the commencement the crust is very adherent to the skin, and if torn off, the derma appears tumefied and bleeding. Gradually it is detached from its centre, while the peripheral portion, which is more recent, is still fixed. There is then found beneath the crust a thin layer of pus, which, when removed, shows the derma still inflamed, and marked by numerous little openings left by the torn-out hairs. The pus raises the crust that covers it, gradually dries in superposed layers—which may or may not be adherent to the parasitic production—and constitutes a new crust that remains after the first one has fallen off, and, contrary to what is the case with that one, this no longer exhibits, especially in its deeper layers, the cryptogamic elements.

This second crust dries in its turn, and falls off in the form of scurf or scales (*dartre furfuracée*), leaving a glabrous surface on which the hair grows in a regular manner immediately, or after a brief epidermic desquamation.

The malady is accompanied by a certain amount of pruritus, which is more pronounced at the beginning and end than in the intermediate period; but it is far from having the same acuteness as in scabies.

The Ringworm may disappear spontaneously after a certain time, varying from six weeks to three months, but in Calves (the animals not being groomed at all) it is more intractable than in adult animals. If it extends over a large part of the body the Calves may lose condition, and the cases recorded by Macorps prove that when there is extreme pruritus it hinders fattening.

What has been said with regard to the course and prognosis of Ringworm in the Horse applies to that of the Ox.

Etiology.—The information, already given regarding the etiology of ringworm in the Horse is fundamentally true of the same disease in the Ox. Evidently want of cleanliness, so favourable to contagion, alone permitted, in 1871, the spread of Ringworm among the Calves collected at Lyons in anticipation of a siege.

The coincidence of the malady with certain seasons, which has been on several occasions alluded to, may be explained in the same way. Thus, Fleming has observed that after having persisted during the winter among Cows, it has disappeared in the spring; but this was because in winter the animals were kept in dark and dirty stables, in which the parasite could thrive indefinitely, while in the spring-time they were turned out to pasture, and consequently placed in conditions opposed to contagion.

Spinola attributed to light some influence on the evolution of the trichophytic patches. It appeared to him that, in the stable, they developed on those parts of the body which received the direct action of the light, and that they were quickly cured when these

parts were removed from it, but reappeared on another region exposed to it. Gerlach, however, formally contested this statement: 'Either chance has intervened,' he said, 'or the exanthem has not been tinea.'

It has already been stated that Calves are much more likely to contract trichophytosis than adult animals. Ringworm affecting the Ox appears to have been observed in every country, but it is most frequent in certain great breeding countries—as in Normandy, La Vendée, Brittany, Holland, Oldenburg, Bavaria—principally in Franconia, England, and Switzerland. It is common also in Australia (G. Fleming). It takes sometimes an epizoötic form. Thus, in the neighbourhood of Adelfingen, and especially in the Commune of Dorlikon—Canton of Zurich—Fehr, in 1838, reported an epizoöty of trichophytosis that prevailed for four years, and was communicated to a number of people; indeed, the majority of the inhabitants of Dorolikon were attacked. But according to the details given by him, it is more probable—as Gerlach suggested—that it was sarcoptic scabies.

In the space of three months Macorps saw ringworm spread to more than 100 cattle in the Canton of Huy (Belgium), and Gigard has witnessed a similar occurrence in the neighbourhood of Lyons, while Pflug mentions that in certain stables the malady reigns permanently. It is the same on certain pastures.

Contagion.—I. *From Ox to Ox.*—Long ago the older veterinarians — Chabert, Grognier, Carrère, etc. — had observed the contagion of *dartres* from one animal to another of the *bovine species.* 'The *virus dartreux*,' says Carrère, 'may be preserved for a long time in parts of stables where Calves affected with the disease have been, if the precaution is not taken of burning the articles which have served to tie them up, and cleaning the different objects against which they may have rubbed.' This observation has been many times confirmed, and Pflug cites an instance in which a Calf, the subject of tinea tonsurans, transmitted the disease — mediately — to all those which were put in the place it had occupied. But it is to Gerlach that we owe precise and definite information on this point, derived, as it was, from experiments as numerous as they were varied. 'In all these experiments, the crusts taken from diseased animals were divided by the fingers and deposited, after some slight rubbings, beneath the hair of those of various ages. The older animals were refractory to contagion, but animals one to two years old, and particularly Calves, took the disease with the greatest readiness. Contagion was more certain if care was taken to previously damp the skin, or to slightly scratch or scarify it. It was noted as something remarkable, that, no matter what may have been the disposition of the inoculated surface even if it were longitudinal, the resulting lesion constantly manifested a tendency to assume a circular form, and to constitute a veritable circle if the inoculation scratch was not too extensive.

'Gerlach even attempted the re-inoculation of parts denuded by the first eruption, but the results were always negative; while a

new eruption was produced, though relatively feeble in intensity, on those parts where the hairs had partially or wholly been restored.

'In order to demonstrate that the contagion was exclusively due to the Fungus, Gerlach inoculated blood obtained by scarification from a diseased patch, as well as sanguinolent serosity derived from beneath a well-formed crust, but not containing any Fungi. In no instance was the inoculation followed by the development of the malady' (Railliet).

II. *From other Animals to the Ox and inversely.*—Reynal has transmitted tinea tonsurans of the Horse to two Calves by grooming them with tools which had been used for two affected Horses. Nettleship has observed similar cases. Ringworm has also been observed to spread from a Goat to an Ox, and mention has already been made of the transmission of ringworm from a Cat to both the Horse and Ox (Williams) (see also p. 254).

Communication of the disease from the *Ox* to the *Dog* succeeded in the hands of Gerlach, when the inoculation was preceded by slight scarifications and the destruction of the epidermis. The Fungus was seen in about six to eight days. 'A young Dog experienced most acute itching; the skin was tumefied, and covered with a somewhat friable crust, which left, after its removal, a circular hairless patch, the size of a sixpence; the hair was not long in growing again. The thin crust was composed of epidermic cells, slightly adherent to one another, and between which no Fungi could be discovered.' Fenger has likewise reported the conveyance of tinea tonsurans from the Ox to the Dog.

Gerlach failed to inoculate the *Sheep* and *Pig* with the tinea of the *Ox*; and Railliet was no more successful with the *Rabbit*. 'Nevertheless,' he states, 'in some otherwise very rare instances, communication of the disease to the Sheep and Pig has been observed.' Such was the instance recorded by Perroncito of a lamb infected from an Ox.

III. *From the Ox to Man.*—As early as 1820 Ernst furnished an instance of transmission of the disease from a Cow to a young girl; and Grognier, Köllreuter, Lavergne, Carrère, and Fehr have made known similar cases. The number of such recorded observations at the present day is considerable.

Such are those of Hintermüller, Epple, in 1839—quoted by Verbeyen, Rademacher in 1844, Houlès in 1845, Höring, Hafner in 1846, of the commission appointed for the study of bovine contagious pleuro-pneumonia in 1849, Cazenave, Malherbe and Letenneur in 1851, Kowack in 1853, Chandeley and Sautlus in 1856. These facts, the most important of which relate to Calves, bring us to the important work of Gerlach, in which the majority of them are analyzed, but in which there is found more particularly the experimental demonstration of the malady from bovines to Man. Gerlach made frequent inoculations on himself and a certain number of students, and had always successful results from them; though he never made these on the scalp, for fear of producing a troublesome

disease, preferring to inoculate the skin of the arm, where he never failed to develop a more or less regular *herpes circinatus*, showing itself from the seventh to the fourteenth day after inoculation. Börensprung, Gerlach mentions, had also inoculated himself with the bovine tinea, and produced a herpes circinatus.

Since Gerlach's experiments, Rüffert, Lemaistre, Macorps, Lafosse, Fünfstück, Bergemann, Nettleship, Pflug, Kretschmar, Besnier, Chaboux, Gerlier, Boucher, etc., have reported other instances of transmission to Man of the ringworm of the Ox, and especially of the Calf.

Contagion may occur in various ways. Most frequently it is caught in attending upon affected animals, and then the patches have a preference for the wrists and fore-arms, and particularly the palmar surface, although they may be found on any part of the body. Calves which are affected around the lips infect the Cows which suckle them, about the teats and flank; and this is why persons in the habit of milking Cows contract tinea tonsurans on the hands—particularly the dorsal surface—wrists and fore-arms, and also on the forehead and scalp in leaning their head against the animal's flank while milking. Horand has seen a trichophytic patch on the posterior surface of the neck of a butcher who had carried a diseased Calf on his shoulders, and a similar occurrence had been previously noted by Cazenave; and according to E. Besnier, herpes circinatus is often seen on the back of the hands and the fore-arms of butchers who skin Calves. It is evident that the parasite may afterwards be transported to any other part of the body, by touching the parts primarily inoculated.

The form which the malady assumes in Man is that of herpes circinatus—vesicular herpes, vesicular trichophytic erythema—for it is the hairless parts which are most frequently attacked. On the scalp it is tinea tonsurans, and on the lip it is a sycosis or mentagra. There is sometimes trichophytosis of the eyelashes, according to Gailleton.

Trichophytosis derived from animals is generally much more acute than it usually is in Man. The vesicles are more numerous, and sometimes suppurate, the pruritus is more intense, and the patches are larger and more intractable to cure.

Treatment.—What has been said with regard to the Horse applies also to cattle. Mercurial preparations are to be used with care, since the animals may by licking the dressings show more or less serious toxic symptoms.

Article III.—**Ringworm of the Sheep, Goat and Pig.**

Little is known about the dermatomycoses of the Sheep, Goat and Pig. From what has been written on the subject, it may be concluded that there are close resemblances in the symptoms to those exhibited in the preceding species, if an account be taken of the differences in their coat.

According to Bräuer, in Sheep affected with trichophytosis it is observed at the beginning that the wool is collected in small irregular tufts, which increase in number and volume ; the fleece is matted in various places. On the neck, chest, shoulders, and along the back, appear furfuraceous and crusted patches, accompanied by marked pruritus, which assists in giving the wool its bad appearance.

Tinea is not very intractable in the Goat.

Ringworm of the **Pig** is found on the croup, sides, flanks and sides of the abdomen ; but most often on the back and outside the thighs. It forms isolated, red patches from 2 cm. to 5 cm. in diameter, covered with miliary vesicles which are soon replaced by brown crusts. The bristles, unaltered, still remain adherent and unbroken. Pruritus is absent. Contagion from Pig to Pig is easy.

The disease may have originated from the Ringworm of the Ox by means of litter brought from the cowshed to the piggery (Schindelka).

Gerlach has not succeeded in transmitting Ringworm from the Ox to either the Sheep or Pig. Perroncito cites a case, however, of contagion from an Ox to a Lamb. Siedamgrotzky has successfully inoculated two Sheep and two Pigs with Ringworm from a Horse and also a Goat with Ringworm from an Ox. The two pigs further transmitted the disease to two others which were brought in contact with them. Infection from the Goat to the Ox has been observed in the Canton of Zurich (1852).

In 1876, Lailler communicated to the Société Médicale des Hôpitaux a letter from Lespiau, relative to an endemic of trichophytosis observed in the cantons of Céret and Arles-sur-Tech, Pyrenees-Oriental. In this outbreak, 34 persons—of whom 28 were children—were attacked ; the malady appeared to have been propagated from a Dog—the first affected—to a Pig, which in these parts lives with the family, and from this animal it was conveyed to Man. The humidity of the season favoured the development of the parasite, which localized itself more particularly about the head—eyebrows and cheeks—and around the genital organs, and caused itching.

ARTICLE IV.—**Ringworm of the Dog.**

Four Dermatophytes are known to affect the Dog : (1) ***Trichophyton caninum*** (Matruchot and Dassonville) ; (2) ***Microsporum audouini*** var. ***caninum*** (Bodin and Almy) ; (3) ***Eidamella spinosa*** (Matruchot and Dassonville) ; (4) ***Ocspora canina*** (Constantin and Sabrazès). Moreover, from a multiple Ringworm of a Dog, and from Ringworm patches (small-celled suppurative folliculitis) on a child living in the same house, Sabouraud isolated a Trichophyton, which in cultures was identical with ***Tr. mentagrophytes*** of the Horse except that it had always a light ***cafe-au-lait*** tint. It is possible, that this may be the common parasite of Ringworm in the Dog, and also that it has been confounded with ***Tr. caninum.***

Symptoms.—I. *Trichophytic Ringworm.*—This variety, rare in

France, is very common in Germany, at any rate in the form of suppurative folliculitis, which may be attributed to *Trichophyton mentagrophytes* and to *Tr. caninum*. According to Gerlach and Friedberger they show great symptomatic analogy with the ordinary Tineæ of the Horse and Ox. The disease is most frequently situated on the head and legs, and usually commences around the lips and eyes; but patches may be found on any part of the body, when the malady has been present for some time.

At the commencement the patches are depilated, circular, and well defined; by increasing in number and extent, they may unite and form irregular surfaces. They are soon covered with crusts, which are at first thin and of a dirty-grey or amianthine hue. The pruritus may be insignificant or very intense. When the latter, in consequence of the rubbing, the crusts are impregnated with blood and serum, and have a colour varying from yellow to brown. The hairs which have not broken are agglutinated, and sores form, which alter the physiognomy of the affection. Beneath the crust there is often observed a reddish-brown or copper tint, with a large number of small nodules the size of a millet seed, formed by swollen hair-follicles. It sometimes happens that the patches project as much as 3 mm. above the level of the skin, their surface being really papulous. Spontaneous recovery is rare.

Inoculation of the Dog, however, with *Trichophyton caninum* has caused the formation of patches, which disappeared spontaneously after a few weeks (Matruchot and Dassonville).

II. *Microsporous Ringworm.*—Patches, oval or round, from 2 cm. to 5 cm. in diameter, may form, by confluence, much more extensive areas with irregular borders. On these dry, greyish, scaly patches there are broken hairs which are easily extracted as they readily break near the root. The part pulled out is seen to be surrounded with a sheath of small spores from 2 μ to 3 μ in diameter, irregularly disposed and without any mycelial filaments; the latter are inside the hair. Pruritus is absent or insignificant (Bodin and Almy).

III. *Eidamellian Ringworm.*—Found only once in the form of lesions like those of Tinea. The parasite produced in the follicle a mycelial close network, with intercalate chlamydospores from 1 μ to 5 μ in diameter. Inoculation with cultures failed to reproduce the original lesion, and only caused complete depilation on a patch 1 cm. to 2 cm. in diameter (Matruchot and Dassonville).

IV. *Favus.*—Favus of the Dog, long attributed to the same species as that causing favus in Man (*Achorion Schönleinii*) is due to a special parasite, *Oospora canina*. The first clinical observations of this dermatosis are due to Saint-Cyr, Trasbot, Siedamgrotzky, and Cadiot. They show that, with young Dogs which are being suckled, tinea favosa often begins at the umbilical region, and that it readily invades a large extent of skin. In the instance given by Trasbot, the head was so covered with favi that there were only a few narrow, sinuous lines still covered with hairs. With a nursing bitch, the abundance of the crusts was revealed by a peculiar odour, which

Trasbot compared to that of mouldy cheese, and which resembled that of similar cases in Man—'a mawkish, repulsive odour,' says Bazin, 'which has some resemblance to that of Mice, Cat's urine, moulds, or macerating animal matters.'

In the case related by Cadiot, the Dog was eight years old, and had four favi—two on one shoulder, one on the neck, and the other at the root of the ear. Each of these was formed of a circular crust, which was white on the surface, sulphur-yellow internally, and around it the skin was slightly swollen. On the left flank, the croup, and at the root of the tail, were other favic patches in process of recovery; they were in the form of hairless red spots, partly covered with slate-tinted crusts rich in spores.

The fungus is found in the lesions in the form of fine filaments from 2 μ to 3 μ in diameter, and of larger filaments which break up into long chains of round or oval elements 5 μ to 6 μ.

Favus can only be confounded with chronic Trichophytosis. Generally in favus the lesions are cupped or hollowed, whilst usually Trichophytic crusts are raised in the centre by moisture which collects beneath them. Further, Favic crusts are almost entirely formed of parasitic elements, whereas Trichophytic crusts show comparatively few of them, and consist of epidermic products, sometimes dried blood, or pus cells.

Etiology, Contagion.—Early age has not for Trichophytosis in the Dog the same predisposing influence as in other species of animals. Inoculation, however, is only successful in young dogs (Horand), although, according to St. Cyr, this hardly applies to Favus.

The bitch that Trasbot exhibited before the central society of Paris, was, it is true, aged nine years; but then it was enfeebled by gestation, parturition, and nursing puppies to such a degree that it realized the condition of physiological misery necessary for the reception of the disease. It must also be remarked, that the Oospora first attacked the offspring—aged from ten to twenty days—and it was from them the parent received the malady, although she was placed in somewhat the same conditions as to contagion. Nevertheless, in Cadiot's case the patient was eight years old, and there was nothing about it to constitute a predisposition.

The *Oospora canina* inoculated on a Dog produces the characteristic lesions of primary favus. These usually spread beyond the point of inoculation, and may even inoculate other parts of the body. They do not disappear spontaneously.

Gerlach (1859) observed the spontaneous transmission of Trichophytosis from one Dog to another, and Friedberger (1876) produced it experimentally.

The Dog may probably contract a form of favus due not to the *Oospora* but to the *Achorion quinckeanum* (Zopf), the parasite of Mouse favus. Trasbot's favic bitch was a terrier, which brought to its puppies the Rats it caught. Anderson has observed—as also has Buchanan—a Dog with a favic cup on one of its forepaws; this animal was in the habit of killing the Mice which swarmed in the

house, and several of these creatures, on being caught and examined, were found to be favic. The primary localization of the malady on the paws and nose of the domesticated carnivora is easily explained.

Contagion to Man.—Friedberger reported, in 1876, a case of contagion of tinea tonsurans from a Dog to a child and servant, with whom the animal was in the habit of playing. The seat of eruption was the face in the child and the neck in the servant; and here also it was the circinated form that it exhibited. Experiments made by the author on himself and three students, with crusts from the Dog and the child, had no result. Horand had already reported a similar fact, and Haas has published another. Transmission from the Dog to Man is rendered easy by the handling and caressing the animal receives; and Fröhner has observed numerous instances of infection which had occurred in this way.

The Microsporum of the Dog is transmissable to Man, causing a Ringworm very like that set up by *Microsporum audouini*, according to the observations of Mitelli and Bunch. The same is true of Favus. St. Cyr contracted it by manipulating affected Dogs used for experiments.

Treatment.—The Trichophytoses of the Dog are not very obstinate. Any of the methods of treatment advised in the case of the Horse may be used with success.

Microsporosis, even when extensive, disappears after painting with pure tincture of iodine, followed by the application of carbolized vaseline.

For Favus Saint-Cyr gives the following treatment: Remove the crusts with a spatula or the blunt end of curved scissors, taking care not to make the skin bleed. Then daily dress the exposed skin with a more or less concentrated solution of corrosive sublimate—2 to 10 per cent.

Sometimes the Favus re-forms, and it is then necessary, at the second application of the lotion, to remove the crust as before. Usually, five or six applications of the lotion are sufficient to effect a cure; though when the disease is situated at the root of the claws, more are needed; but the malady is always overcome in a short time.

Corrosive sublimate may occasion poisoning, and it is perhaps preferable—as Saint-Cyr advises, and as Trasbot, following his advice, has successfully employed—to apply an ointment of 1 or even 5 per cent. nitrate of silver. This ought to be carefully rubbed in to assure its penetration.

ARTICLE V.—Ringworm of the Cat.

The dermatomycoses of the Cat comprise a Trichophytosis, a Microsporosis, and a Favus.

Trichophytosis.—Fenger, who has seen tinea tonsurans in the Cat, says that it consists of circular depilations covered with abundant scales, the patches attaining a diameter of 15 mm. to 35 mm. in

three weeks. This ringworm is due to a particular species—the *Trichophyton felineum* (R. Blanchard), well studied by Sabouraud, who has not found it on any of the other animals in which he has observed spontaneous Trichophytosis. It appears to be especially ectothrix, and the lesion is quite temporary. The fungus gives white cultures very similar to those of *Tr. mentagrophytes* of the Horse.

The case recorded by Williams seems to prove that this Ringworm of the Cat is transmissible to the Horse and Ox. Fenger states that it may pass from the Cat to the Dog, and according to Zürn the Cat may contract it from the Dog.

It is contagious also for the human subject, in whom it is nearly confined to women and children. Fenger states that he has inoculated the Cat with the *Trichophyton tonsurans* of Man. Horand and Vincens have succeeded equally in inoculating young animals.

Microsporosis.—This tinea, observed once by Marotel, on a Cat several months old, was manifested by three hairless patches, of the size of a shilling, covered with abundant dry, greyish scales. The fungus formed round the hair, within the hair follicle, a sheath made up of small spores about 2 μ, polygonal in shape, and crowded without order one against another.

Favus.—The Favus of the Cat was mentioned for the first time in 1847, in a thesis by Jacquetant of Lyons. Zander observed it again in 1858. Ten years later Saint-Cyr published his important work on *Tinea favosa* of the domesticated animals, and gave a good description of this disease.

The dermatophyte of Favus of the Cat has not yet been studied in cultures, but its etiological conditions suggest that it is caused by the agent of Mouse favus—the *Achorion quinckeanum* (Zopf). It is possible also that certain cases are due to *Achorion Schönleinii* (Lebert), the parasite of Favus of Man.

Symptoms.—In the *Cat Tinea favosa* attacks the extremity of the toes or base of the claws, by preference; but it may commence at the umbilicus, or on the sides of the chest. Gradually it extends—by first invading the head—especially the forehead, root of the ears, and dorsal line of the nose, then the external surface of the thighs and various parts of the body. The malady is characterized by crusts more or less thick—from about 1 mm. to 4 mm.—rather viscid in consistence, of a sulphur-yellow colour when recent, becoming grey or yellowish-grey as they are older; they are arranged quite like those of the Favus of Man. 'Their contour,' says Saint-Cyr, 'sometimes very regularly circular, at other times rather notched, forms a rim slightly raised above the level of the surrounding skin; their centre is, on the contrary, more or less markedly depressed, which gives to the whole of the crust a cupulated or cup-shape.' The favic cup or *favus* has a varied diameter, there being those which are no larger than the head of a pin, while others attain the dimensions of a franc-piece—many intermediate sizes being found. Their prominence is not subordinate to their size,

as some form patches which are scarcely raised above the level of the epidermis. The cupulated arrangement is much less marked when the crust is seated at the root of the claw. 'There is then most frequently only a heap of yellow, viscid, split-up crusts, which the microscope shows are evidently formed by the same elements as those above described' (Saint-Cyr). The deformation of the crusts may also be the result of their confluence; when they become multiplied on a limited surface, they are pressed together, so that their primary characters are more or less masked. From their free surface there are often seen projecting erect, rigid, and lustreless hairs, which appear to pass through them, and which the slightest traction pulls out. Later these hairs are shed, thrown out of their follicles by the parasite.

'If the crusts are carefully removed, the skin beneath them is observed to be thinner, depressed, and looking as if atrophied by compression; but smooth, not ulcerated, quite dry or slightly moist from serum, and sometimes pale and anæmic-looking, but more frequently red and irritated, and showing, in its transparency, some very fine bloodvessels. At the margin of the crust the skin is sensibly inflamed—red, tumefied, and forming a somewhat salient ring' (Saint-Cyr).

The malady is accompanied by only a very slight pruritus, and does not appear to have an injurious influence on the general health.

The *Achorion quinckeanum* appears in the lesions in the form of numerous rectangular or ovoid elements $2{\cdot}5\ \mu$ to $3\ \mu$ broad, and $3\ \mu$ to $5\ \mu$ long, united into mycelial filaments of varying length, which split up into short rectangular spores.

Favus of the Cat is not usually serious. Saint-Cyr has seen a Cat recover without any treatment in about three months.

Etiology, Contagion.—Early age seems to be almost an essential condition to the implantation of *Achorion* on the Cat. Saint-Cyr twice tried to transmit Favus to adult Cats and failed, whereas *inoculations of seven or eight Cats, from six weeks to two months old*, were all successful. Whenever it has been possible to recognise the origin of Favus in a Cat, it has always been traced to the Mouse or the Rat. These rodents are, in fact, often affected with tinea, and, since the time of Bennett, corroborative testimony has been furnished by Draper, Friedreich, R. Tripier, Mollière, etc. Favic Mice appear to be particularly frequent at Lyons, and the disease—which usually begins at the ear with them—often causes death. It is difficult to arrive at a definite conclusion as to whether the Favus of Mice is derived from that of Man, in consequence of the peregrinations of these little rodents among the clothing and head apparel of the diseased; but it is certain that they can convey the malady to mankind.

Anderson has reported a case of Favus on a little girl who had touched Mice caught in a trap, and who conveyed the disease to the majority of the members of her family. A few days after this occurrence five Mice were captured, and Anderson found a favic cup

on the back of one of them, near the tail, while another had the si of the head and the ears ulcerated by the malady. Dr. Trip of Lyons, successfully inoculated himself from a Mouse; Horand, of Lyons, has given the case of a woman who had contrac Favus by introducing her hand into a rat-trap containing a favic I

In general, the transmission of Favus from the Mouse or Ra Man is effected through the medium of the domesticated anim It is, in fact, from the Mouse that the Dog and Cat acquire malady in cases the origin of which can be ascertained. Such the case of the Cat mentioned by Draper, and probably also in those in which the disease was observed.

Like the Mouse, the Cat affected with Favus may transmit disease to Man. In Draper's case a Cat gave Favus to two child who were in the habit of playing with it. Saint-Cyr, Hora Anderson, W. G. Smith have all cited similar cases.

Treatment.—The same as that indicated for Favus of the Dog

ARTICLE VI.—**Favus of the Rabbit.**

The only tinea recognised in the Rabbit is a Favus It is known to what Dermatophyte it belongs, or whether it is really *Achorion*. It is certain, however, that the *Achorion Schönleini* human Favus can be inoculated on the Rabbit (Sabrazès).

Favus of the *Rabbit* has been seen by Mourrand of Lyons, Recordon of Corbeil, and by Mégnin. Mourrand's observa relates to some young Russian Rabbits on which the disease disseminated on the paws, head, and body, but was more part larly localized on the first two regions. On one animal there v from 25 to 30 favi on each ear, and their dimensions were betw that of a pin's head and a twenty-centime piece. Some, which v of the volume of a small lentil, had a small tuft of hairs in t centre. Otherwise, by their characters they were absolutely same as those of the Cat. In Recordon's observation, then mention made of a litter of twelve silver Rabbits, and the local tion of the disease was the same as in the preceding instance. fur Rabbits, Mégnin has seen the malady in the form of isol crusts, somewhat globular, circular, and flattened; they v from 1 cm. to 1½ cm. in diameter, and coriaceous only on the surf which was easily torn, and then there escaped a powdery w matter, that was formed exclusively of *Achorion* spores. By resemblance to the *Lycoperdon* or Puff-ball, Mégnin has given to variety the name of *lycoperdoid* Favus. It only affects Rabbit two or three months old—sparing those of greater age, and di pearing altogether from the diseased ones when they attain t fourth month.

Favus of the Rabbit has a tendency to disappear spontaneou Here again early age seems to be an important predisposing fa The rabbits observed by Mourrand were two to three months and those noted by Recordon did not appear to have passed that

ARTICLE VII.—Tinea of the Fowl.

The Fowl is the subject of a cutaneous mycosis which is known under the names of *Favus*, *white comb*, and *comb disease*, but which has nothing in common with Favus of Man, nor with that of the small mammals. It is caused by a special fungus, allied to *Trichophyton*, and named *Lophophyton gallinæ* (Mégnin), *Trichophyton Mégnini* (R. Blanchard).

This Ringworm or *Lophophytosis*, observed in the Fowl in 1858 by Gerlach, by Müller, and by Leisering, was again described by Mégnin in 1881. The parasite, at first erroneously connected with *Achorion Schönleinii*, has been recognised as quite distinct, since it was cultivated by Duclaux (1890), then by Constantin and Sabrazès (1893), and lastly studied with great care by Matruchot and Dassonville (1899).

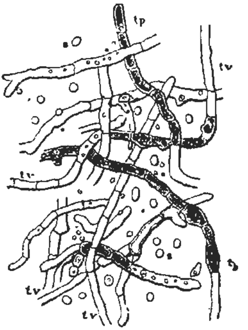

FIG. 116.—The fungus of the Favus of Poultry; magnified 800 diameters.

tv, empty tubes; *tp*, tubes filled with protoplasm and containing spores; *s*, isolated spores.

Symptoms. — The Tinea of Poultry generally commences on the comb or crest, and the barbs and wattles. It manifests itself in the form of small, white or light-grey, round or irregular, spots that extend, multiply, and become confluent, constituting an almost continuous thin covering or coating, of the same colour as the original patches. This gradually grows thicker, and in about twenty to thirty days it may be 8 mm. It is then a dry, squamous crust, of a dirty-white colour, irregular on the surface, sometimes a little amiantaceous, and often formed of concentric deposits. When this covering is removed, the skin beneath is seen to be slightly excoriated. From the nude parts of the head, the malady extends to the surfaces covered with feathers—the neck and body, and more especially the cloaca and adjoining parts. On the points attacked, the feathers become erect, dry, and friable; their cavity is filled with discoid superposed crusts, or—if these are cylindrical—they are contained one within the other; and exceptionally there are met with here—as well as on the barbs—the amiantaceous deposits observed on the surface of the nude skin. Lastly, the feathers fall off, leaving the skin denuded and covered with crusts that often compose discoid masses, having in their centre an infundibulum left by the shedding of the feather.

The disease gradually brings on debility, wasting, and may terminate in death.

The affected Fowls exhale a mouldy odour, analogous to that noticed from people who suffer from the malady.

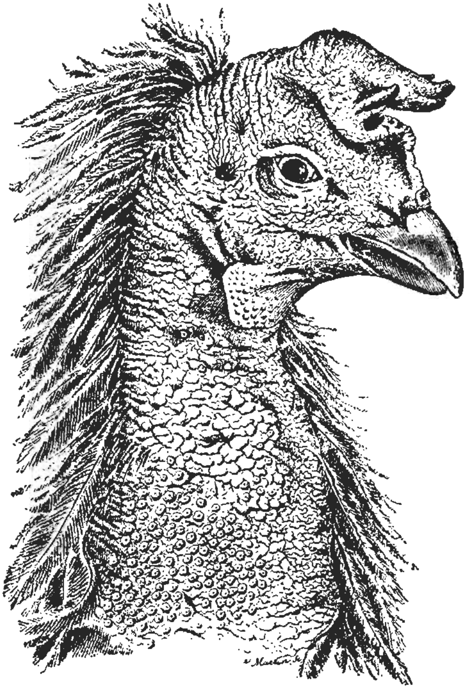

FIG. 117.—Head and neck of a Fowl affected with Generalized Favus.

When the scales from the comb of a diseased Fowl are examined under the microscope, the parasite is seen to be made up of two kinds of elements: (1) Twisted mycelial filaments, often rather

long, contour irregular, measuring 2 μ to 5 μ broad, with thin walls and unequal segments, and presenting articular facets which correspond to detached lateral branches; these pieces are generally devoid of protoplasm, and are as a consequence sterile. (2) Short mycelial fragments, straight or curved, sometimes bifurcated, made up of three or four cells with a thick membrane with refringent protoplasm, and measuring about 15 μ to 20 μ long, and 4 μ to 6 μ broad; these fragments represent a broken-up mycelium. They are of service only in the preservation of the lophophyton, and in the propagation of the disease They have no spores (Matruchot and Dassonville).

Favus may be confined to the comb, and may disappear spontaneously, of which we have seen one example. Heim has observed a case of extensive Favus which recovered without treatment, the recovery coinciding with the autumn moult. But, in general, when it extends beyond this part and the barbs and wattles, and has invaded the parts covered with feathers, the prognosis is more serious because of the loss of condition, and consequent depreciation in value of the animals; while it is all the more onerous from the expense and trouble of treatment.

Contagion.—Transmission from Fowl to Fowl is by simple contact, or lophophytosis may be produced by simply rubbing a Fowl's comb with matter collected from the comb of a diseased Fowl.

The lophophyton cannot be inoculated on the Rat or Dog. On the Mouse it forms cups analogous to those of Favus. It takes almost infallibly on the Rabbit, and develops after the manner of an ectothrix Trichophyton. Man may be very easily inoculated with lophophyton, which produces large scaly erythematous patches, and numerous filaments which spread over the surface in the interstices of the superficial horny cells (Constantin and Sabrazès).

Sabouraud has met with it three times in Man, in lesions of the beard resembling those of *icthyosis pilaris*; its origin from the Fowl was probable.

Treatment.—When the tinea of Poultry is still confined to the nude parts of the head, it should be treated with either benzine or carbolic acid incorporated with soft soap, in the proportion of 1 to 20, one application being made every day; or calomel ointment—1 to 8; the corrosive sublimate solution; Fowler's solution of arsenic; or an ointment of red oxide of mercury—1 to 8 of lard (Zürn).

ARTICLE VIII.—**Onychomycosis of Equidæ.**

In 1855, Virchow described, under the name of *Onychomycosis*, certain affections of the nails of Man which produce alterations in these parts, and are accompanied by the presence of varied parasitic organisms. From the studies subsequently made, it appears that the Fungus of onychomycosis of Man is very analogous to, if not identical with, either the *Achorion Schönleinii* or the *Trichophyton*; in fact, this somewhat rare malady coincides most frequently with favus or tinea.

In 1876, Ercolani applied the same designation to the affection of the hoof of Equidæ—more frequent in the Ass and Mule than in the Horse—known for a long time as *fourmilière* (English *vulgo*, 'seedy-toe'), which usually appears as a complication of laminitis, and consists in a cavity at the front (toe), of the hoof between the wall and keraphyllæ. In the powdery horn occupying this space, Ercolani always found a Fungus constituted by a mycelium, receptacles, and spores, which he considered the cause of this disease, and which he regarded as different from that of favus or tinea, because he could not produce any manifestation of tinea favosa or trichophytosis on the skin of two Asses which had been sprinkled with conidia and filaments obtained from the diseased foot of another Ass—the skin having been previously prepared by a blister. This Fungus should be a particular kind, and Ercolani has given it the name of *Achorion keratophagus*.

He was dealing, without doubt, with an inferior vegetable organism allied to the moulds—such as are found in quantities on dead animal matter, like the powdery horn of this condition. What supports this view is that, in one of his cases, Ercolani found—along with the Fungus—a certain number of living Acarina which he has figured, and which appear to us to be at least related to *Rhizoglyphus echinopus* (Fum and Robin)—a species that lives on dead organic substances. On the other hand, it is necessary to ascertain if the *Achorion keratophagus* is not met with in other affections—such as the so-called 'canker' and 'thrush' of the foot, in the dust of the lateral lacunæ, or even in the hoofs from dead animals placed in conditions favourable to mouldiness.

Baldoni has attempted to prove the rôle of the *Achorion keratophagus* in the etiology of 'seedy-toe.' He claims to have found it in all the feet affected with this lesion which he has examined. He has made cultures, but has tried in vain to inoculate the various domesticated animals and man. Neither has he been able to transmit it to the fore-feet of four Donkeys. But he has seen it grow on dead feet and on pieces of horn, on which it reproduced cultures of the fungus. This last result, with other evidence, proves, contrary to the conclusion of Baldoni, that the *Achorion keratophagus* is not the active agent of 'seedy-toe,' but that it lives in a diseased foot as a simple saprophyte.

BOOK II

PARASITES OF THE DIGESTIVE APPARATUS

THE digestive apparatus affords an asylum for the largest number of parasites, and it is predisposed to their invasion by its relations with the external world. An infinity of germs enter it along with the food and drink—either as ova or larvæ, or in a special and somewhat advanced phase of development. The drink plays, in this respect, the most important part; as water is, in fact, the vehicle for a multitude of microscopic organisms, which it more or less preserves. In dry food, on the contrary, the germs have generally lost their vital properties, along with the water that was inherent in them. The special study that we shall make of each parasite in its pathogenic rôle, will show distinctly the part nearly always played by water in the etiology of parasitic diseases.

Of the germs introduced into the digestive apparatus, a large number perish there, either because—having arrived too early or too late—they have not yet attained, or have exceeded, the phase of development that would permit their profiting from this conjuncture; because they cannot find there the conditions required for their evolution; or because some individual and indeterminable circumstance places them in this condition of inferiority. They are then dissolved by the digestive juices. Those which ingestion by one of the higher vertebrates has not destroyed, and for which it realizes a condition necessary—in some way provided for and ready—to their development, experience a modification that enables them to make the most of their good fortune. Each is arrested in the section or compartment that suits it, by the action of natural laws; this may be the mouth or pharynx, or the œsophagus, stomach, intestine, etc. If the germs are introduced therein in small quantity, most frequently they do not occasion any appreciable trouble; but this is not so when they are numerous, and in this respect also distinctions must be made according to the species of parasite—for many can multiply in the digestive canal, without betraying their presence by any derangement in the health of their host.

In general, the number of the parasites is exactly that of the germs introduced, which have profited by their congenial situation;

they are rarely more than this, for the species capable of multiplying in such a place are very few in number—at least among the *Helminthes*.

The vegetable parasites of the digestive apparatus which do not belong to the Schizomycetes, are little varied, and with the exception of the *Saccharomyces albicans*—the parasitic element of thrush (of children and young animals)—they are of little importance. There is, therefore, no need to include them in these general considerations.

It is not the same with regard to the animal parasites. Very numerous and very diverse, these belong to the Sporozoa, Infusoria, Cestoda, Trematoda, Acanthocephala, Nematoda, Annelida, and Insecta.

Of these diverse groups, there are some representatives which are localized almost absolutely in a particular compartment of the digestive apparatus. These are the Cestodes, which—as parasites of this apparatus—only develop in the intestine; the Acanthocephala are also intestinal parasites; the Annelida—represented by the Hæmopis, which lives in the mouth, pharynx, and nasal cavities; and the Insecta — represented by the larvæ of the Œstridæ—which more particularly fix themselves in the stomach. The special study of these four groups will more appropriately find its place in the chapters devoted to the parasitism of their particular *habitat*.

A. The **SPOROZOA** that may be found in the digestive organs belong to the *Coccidia* or *Psorospermiæ*. The majority are parasites in the interior of the epithelial cells of the liver, intestine, etc. The evolution of these parasites is complex. In their most characteristic form they are ovoid cysts filled with granular protoplasm, and limited by a transparent membrane or shell. The protoplasm contracts into a nucleated central sphere. At this stage (*oocyst*), the coccidium ruptures the cell into which it had penetrated, falls into the cavity of the biliary canals, the intestine, etc., and is passed out with the excreta. If the conditions are favourable its central mass divides into four spherules or *sporoblasts*. Each sporoblast elongates, surrounds itself with a double membrane, and becomes a *sporocyst*. Each sporocyst in its turn divides into two or several *sporozoites*, accompanied usually by a *reliquat* of differentiation.

The cyst in which the sporozoites are formed, being introduced afresh into the intestine, ruptures under the influence of the digestive juices, and the sporozoites are set free. Being motile and provided with a nucleus they fix themselves to the surface of the epithelial cells, and finally penetrate their interior. The sporozoite grows at the expense of the invaded cell, becomes very nearly globular (*schizont*), and divides (*schizogony*) into a large number of club-shaped corpuscles (*merozoites*), which separate from one another. The invaded cell ruptures and liberates the merozoites. Some of the latter perish, while others individually penetrate into other cells of the host, becoming schizonts, and, by repeated schizogony, produce new merozoites. The latter may behave like the first formed merozoites, or, like them also, some may become female elements (*macrogametes*), the others male elements (*microgametocytes*) after their penetration into a cell. The macrogamete, without undergoing division, but after certain modifications, is fecundated within the invaded cell or after leaving it. By division of its nucleus the microgametocyte breaks up into a large number of falciform elements furnished with two very mobile flagella; these are the *microgametes*. A microgamete

unites with a macrogamete, which is thus fecundated, and gradually attains the state of oocyst to recommence the cycle. The infested host therefore harbours a number of parasites far in excess of that of the germs which have been introduced by ingestion.

B. The **INFUSORIA** are included in the two sub-classes of *Flagellata* and *Ciliata*.

The flagellate Infusoria, having representatives in the digestive organs of the domesticated animals, belong to the genera *Monocercomonas*, *Trichomonas*, and *Lamblia*.

a. **Monocercomonas** (Grassi).—Four anterior flagella, three of which are directed forward, and a long one thrown backward, beyond the posterior extremity of the body; no posterior flagellum.

b. **Trichomonas** (Donné).—Four or five anterior flagella directed forward, with the exception of one, which extends backward, and is longer than the body, to which it is fixed for the greater part of its length by a very thin membrane; no posterior flagellum; a single longitudinal rod in the interior of the body.

c. **Lamblia** (R. Blanchard).—A large anterior depression in the form of a sucker; two flagella at the posterior extremity.

The **Ciliate Infusoria**, are usually divided into four orders, according to Stein's classification:

Cilia covering the entire surface of the body.	All the cilia alike and short .	*Holotricha.*
	A row of long and strong cilia around the mouth . .	*Heterotricha.*
Cilia occupying only the ventral surface . . .		*Hypotricha.*
Cilia arranged in a crown around the mouth, and often also in the form of a girdle		*Peritricha.*

The Holotriches, Heterotriches, and Peritriches are met with in the digestive canal of the domesticated Mammalia.

C. The **TREMATODE** parasites of the digestive tube are the **Distomata**. Their suckers—which are always situated on the ventral surface—are almost hemispherical, salient cupules, comprising a complex system of muscular fibres, the contraction of which tends to produce a vacuum in the cavity of the apparatus, whence results a close adhesion between the parasite and the mucous membrane of the host.

The nervous system—which, up to the present time, has only been examined in a small number of species—comprises two sub-œsophageal ganglia united by a transverse commissure, and sometimes a single sub-œsophageal ganglion joined to the others by two lateral commissures, and some nerve filaments. The digestive tube is represented by a nearly always bifurcated cavity, with simple or ramifying branches, and constantly terminates in a *cul-de-sac*: there is, therefore, only one opening—the mouth—situated usually at one of the poles of the body, at the bottom of a sucker, which is, for this reason, named the *oral* sucker; this mouth acts as an anus. The circulation is lacunary. The excretory apparatus consists of a network of fine canaliculi, which converge into canals that become gradually larger, and finally end in one or several longitudinal vessels that, in their turn, unite near their termination at the posterior extremity of the body, and are sometimes dilated into a single pulsatile vesicle—the *vesicle of Laurer*: the entire system opens externally by an excretory pore—the *caudal foramen*.

With rare exceptions, the Trematodes are hermaphrodite. The male organs usually consist of two tubular or mammillated testicles, the different canals of which unite into a *cirrus* or penis, which is enveloped in a sheath (*pouch of the cirrus*) opening externally by an orifice that has a variable situation. The female organs comprise an *ovary*, or *germigen*, the ova from which are evacuated by the *germiduct*. To the ovary are added the albuminiferous or *vitellogenous glands*—very numerous glandular *culs-de-sac* secreting a granular fluid, and joining to form two longitudinal canals—the *albuminiferous canals* or *vitelloducts*, which are in their turn joined by a transverse canal into which

opens the germiduct, and from this reunion results the *oviduct*. This confluence of vessels is enveloped by the *shell gland*. The oviduct is continued by a flexuous irregular tube (the *uterus*), the terminal portion of which (the *vagina*) opens at a short distance from the male orifice.

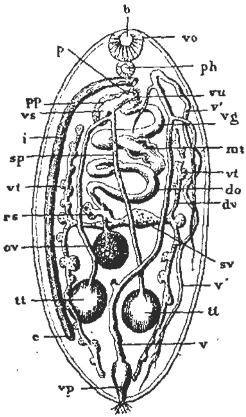

FIG. 118.—Diagram of the organization of a Trematode.—After P. J. van Beneden.

vo, oral sucker; *b*, mouth; *ph*, pharyngeal bulb; *i*, one of the intestines terminating in a *cul-de-sac* at *c*, the other intestine being removed; *v v'*, excretory vessels and their divisions; *vp*, vesicle of Laurer; *tt*, testicles; *sp*, deferent canals or spermiducts; *pp*, scrotum of the penis; *vs*, seminal vesicle; *p*, penis; *ov*, germigen or ovary; *sv*, vitellogens; *dv*, vitelloducts; *sv*, vitellosac, or dilated confluent of the vitelloducts; *rs*, seminal reservoir; *do*, oviduct; *mt*, uterus; *vg*, vagina, showing its orifice or vulva, *vu*, beneath the penis.

The Distomea are oviparous, their development being related to their metamorphoses and migrations, which have been well studied in some species, and to which we shall have to refer when making a particular examination of these creatures.

In the uterus the ova undergo segmentation, and not unfrequently the embryo is even formed there. When they are laid, or have arrived in a moist medium —which is generally water—they continue their development, and at the end of a certain time there issue from them embryos, which are sometimes nude, sometimes ciliated (*infusoriform embryos*). After a sojourn more or less prolonged in water, these embryos have to enter the body of an aquatic creature—usually a mollusc—and there they lose their cilia, and are transformed into a more or less complex organism—a kind of sac generally furnished with a sucker (the *germinative sac*), which may be destitute of mouth and digestive tube (the *Sporocyst* of Van Beneden), or may possess one or other of these (the *Redia* of Filippi). These germinative sacs may engender others, by fission or by budding. They represent the second phase of external development.

Each Sporocyst, or Redia, produces new organisms in its interior named *Cercariæ*, which in their organization resemble the adult Distomea; they have suckers like them, but they differ from them in having no genital organs, and in the presence—at the posterior end of their oval bodies—of a very movable simple or bifid tail.

At the end of a certain time they escape from the germinative sac, leave the body of their host, swim or crawl in the water, waiting for the advent of another aquatic animal—mollusc, worm, larva of an insect, more rarely a fish or batrachian. Ercolani has found them in terrestrial molluscs; and they may sometimes fix themselves on certain plants or inorganic bodies, in the vicinity of their liquid medium. Arrived in their new abode, they lose their caudal appendage, become encysted, show traces sometimes of their sexual organs, and—as agamous Distomata—they now await the chance of being carried into the stomach of a third host, which swallows the second. The latter is digested, the cyst is dissolved, and the parasite being set free, reaches the organ which is to be its definite abode—intestine, biliary canals, urinary bladder, respiratory apparatus, sub-orbital sinus of birds, etc. There the Trematode, acquiring its genital organs, attains the adult state.

Such is a general description of the evolution of the Distomata. According to the species, it is more or less complex, and varies also according to the media in which development occurs (Ercolani), as well as climatic conditions (Pagenstecher). Thus it is that, in the *Monostomum mutabile*, the embryos already carry the germinative sac in their body, and that in certain cases these sacs are seen producing cercariæ without tails—that is, agamous Distomata, etc.

The important part water plays in the succession of the various phases of development, explains why the Trematodes are more particularly met with in the aquatic vertebrata, and —amongst the terrestrial animals—those which frequent humid places.

The parasitic species infesting the domestic animals may be divided into two families: *Monostomidæ* and *Distomidæ*.

1. MONOSTOMIDÆ. — These have only one sucker, which is situated at the anterior part of the body. The genera are *Monostomum, Holostomum, Hemistomum.*

a. **Monostome** (*Monostomum* Rud.). —The sucker is only slightly developed, and the mouth is situated at the bottom of it. This genus has representatives in the intestine of Poultry.

b. **Holostome** (*Holostomum* Nitzsch). —The anterior part of the body—which is separated from the other part by a constriction—is dilated into a large cupule that plays the part of a sucker, and opens directly in front. The posterior part is narrow and more or less rounded. One species has been found in the intestine of the Duck.

c. **Hemistome** (*Hemistomum* Dies). —This differs from the preceding more particularly in its anterior cupule, which is truncated in such a manner as to open obliquely in front, and has the mouth at the summit. One species is sometimes met with in the Dog.

2. DISTOMIDÆ. — These have two suckers—an anterior, oral; a second, ventral, with variable situation according to the genera. These are *Distomum, Mesogonimus, Amphistomum, Gastrodiscus,* and *Bilharzia.* The latter is not a parasite of the digestive system, but of the circulatory apparatus.

a. **Distome** (*Distomum* Retzius).—This genus is characterized by its anterior sucker, which is destitute of

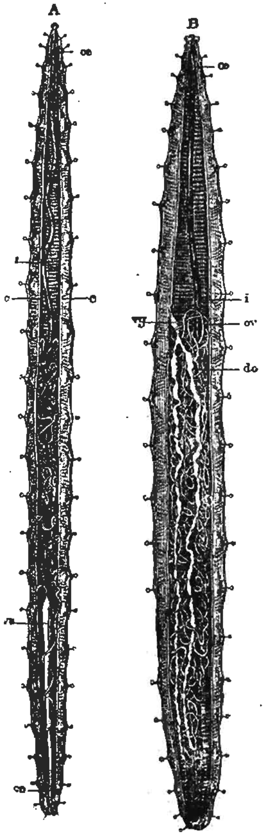

FIG. 119.—Anatomy of the Ascarid of the Pig.—Delafond.

A, male; B, female; *c*, lateral border; *œ*, œsophagus; *i*, intestine; *vs*, seminal vesicle; *ce*, ejaculatory duct; *ov*, ovaries; *do*, dilated portion of the oviduct or uterus; *vg*, vagina.

protractile tentacula; by two portions or arms of the intestine that are separated throughout their length; and by its genital openings situated in front of the posterior sucker. In consequence of the large number of species it contains, this genus has been divided into nine sections, or sub-genera: *Kœlliheria*, *Apoblema*, *Cladocœlium*, *Brachylaimus*, *Brachycœlium*, *Dicrocœlium*, *Podocotyle*, *Echinostomum*, and *Crossodera*. The parasitic species of the domesticated animals belong to the sub-genera *Cladocœlium* and *Dicrocœlium*, both of which are hermaphrodites, with their anterior sucker destitute of

FIG. 120.—Digestive tube of a female of the *Sclerostomum equinum*.—Delafond.

c, buccal capsule; *œ*, œsophagus; *i*, intestine; *a*, anus; *g*, *g′*, so-called salivary glands.

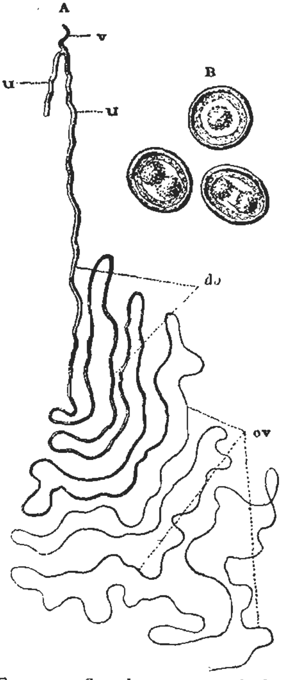

FIG. 121.—Sexual apparatus of the female Ascaris Megalocephala (*A. equorum*).—Delafond.

A, one of the sexual tubes, the other having been divided a short distance from the vagina: *ov*, ovary; *do*, oviduct; *u*, uterus; *v*, vagina; B, ova magnified about 130 diameters.

prickers, and the body non-appendiculated posteriorly. The *Cladocœlium* has the intestine bifid and branching. The *Dicrocœlium* has the intestine also bifid, but not branched, and with very long arms; the mouth is succeeded

by an œsophagus, and the posterior sucker is sessile. A species of Distomum has been found in the intestine of the Dog; others live in that of poultry. But the most interesting species are met with in the biliary canals of various animals.

b. **Mesogonim** (*Mesogonimus* Monticelli).—This genus is the result of division of the genus *Distomum*, and is distinguished by its genital openings being situated behind the posterior sucker which is sessile, and larger or smaller than the anterior, which is orbicular. A species lives in the intestine of the Fowl.

c. **Cephalogonim** (*Cephalogonimus* Poirier).—The species of this genus have also been separated from the Distomum, by reason of the genital openings being situated above and to the side of the oral sucker. One species has been found in the œsophagus of the Fowl.

d. **Amphistome** (*Amphistomum* Rud).—The body is thick, muscular; somewhat dense; ovoïd, cylindroïd, or conoïd; often curved, and two or three times longer than it is broad. The anterior sucker is small, and has the mouth at the bottom. The second sucker—relatively very large—is placed at the posterior extremity, which is truncated obliquely on the ventral surface. The branches of the intestine are not ramified. Several species live in the paunch of the Ruminants; one is found in the intestine of the Ox, and another in that of the Horse.

e. **Gastrodisc** (*Gastrodiscus* Leuck).—The ventral sucker is situated at the posterior border of the body, as in the Amphistomes; but the ventral surface is studded with numerous papillæ-suckers. An exotic species lives in the digestive tube of the Horse and Mule.

D. The **NEMATODES** (Figs. 119 to 121) may be white, yellow, brown, red or marbled. The surface of the body is smooth or transversely striated though sometimes it is longitudinally so; it is formed of a chitinous *cuticle*, which is transparent, firm, and elastic, divisible into several layers, and sometimes showing tubercles, spines, hairs, etc., or forming expansions or wings. Beneath the cuticle is the *hypodermis* or *sub-cuticular layer*, which is soft, granular, and nucleated, and in relation—by its inferior surface—to the *musculo-cutaneous* or *muscular layer*, formed of contractile cells, the majority of which are longitudinal and often grouped in series. It is nearly always interrupted by four *longitudinal lines*—two situated on the right and left are the *lateral* regions—which sometimes acquire the same breadth as the muscular regions. The latter are thickenings of the hypodermis traversed by one, sometimes two or three excretory canals—*aquiferous vessels*—which unite into a single, short canal that opens externally by a ventral *excretory pore*, at the termination of the œsophagus. The two other lines are intermediate to the preceding, and are narrower; they are the *middle* or *dorsal*, and *ventral lines*.

The cephalic extremity—which may or may not be distinct from the rest of the body, and armed or not armed, winged or not winged—has at its summit the orbicular or elliptical mouth, ordinarily provided with three or six soft or horny lips, which are nearly always garnished with papillæ. The digestive canal extends from one extremity of the body to the other. The mouth sometimes opens in an infundibulum—*buccal capsule*—which is continued by the œsophagus. The latter is often the first digestive compartment; it is a narrow tube, with thick, muscular walls that are at times constricted posteriorly to form a dilatation—the *ventricle*. The intestine—that succeeds the œsophagus—is simple, has thin walls, and is scarcely, if at all, flexuous; it terminates in the rectum, which is narrower and slightly muscular, and this, again, ends in the anus, which is always ventral, and terminal or nearly so. To this digestive tube, and principally in its anterior part, are often annexed glandular organs.

The respiration is exclusively cutaneous. The circulation is lacunary—a *plasmatic fluid* that fills the visceral cavity, and bathes the viscera, is thrown into irregular oscillations by the contractions of the musculo-cutaneous envelope. There is usually a nervous system constituted by an œsophageal collar, from which arise a ventral, a dorsal, and lateral nerves. There are tactile papillæ, and sometimes ocular spots.

The sexes are always separate—at least, in the species that interest us. The male—which is habitually smaller than the female—is usually recognised by its tail, this being more curved. Its genital apparatus is generally composed of a single testicle—a flexuous tube continued by a deferent canal that ends along with the digestive canal, in a cloaca. The latter generally contains, in its posterior part, one or two elongated chitinous pieces (spicules) which serve to fix the female during copulation. In certain cases, copulation is aided by the presence of a *caudal pouch*—a campanuliform expansion that keeps the male closely united to the female. The females have one or two filiform ovarian tubes arranged in more or less numerous convolutions, and continued by a wider portion—the uterus—that opens into a vagina terminating in a vulva, the situation of which is always ventral, and near one or other extremity of the body. The Nematodes are oviparous or ovoviviparous. Those which are parasites pass through various phases to accomplish their development—sometimes the ova may become evolved in the definite host; at other times, the embryos—and even the individual adults—pass a portion of their life in the external world; and, again, at other times they require an intermediate host before reaching the one in which they assume their adult form. Each of these modes includes several types, an examination of which will be made when dealing with each parasite.

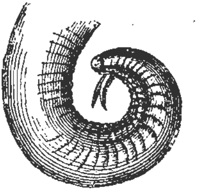

FIG. 122.—Caudal extremity of the male of the Ascarid of the Pig, lateral view; the spicules are a little too thick.—Delafond.

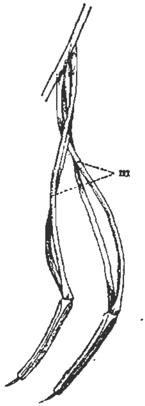

FIG. 123.—Spicules of Ascaris Megalocephala (*A. equorum*), with their retractor muscles, *m*.—Delafond.

The Nematodes have been divided into a great number of families, seven of which furnish the parasites of the digestive apparatus in the domesticated animals. These are: *Ascaridæ*, *Oxyuridæ*, *Strongylidæ*, *Tricholrachelidæ*, *Filariidæ*, *Gnathostomidæ*, *Angiostomidæ*.

1. ASCARIDÆ.—The Ascarides have the body cylindroid. The mouth is usually surrounded by *three lips* which are often papilliferous—cephalic or buccal valves, one of which is dorsal and the other two are ventral. These lips have powerful muscular masses, which can be distinguished by their dark tint seen through the cuticle. The œsophagus is long, muscular, and bulging in its posterior part. The males are provided with *two spicules*. The females have a double ovary, and the vulva is situated in front of the middle of the body (Railliet). The genera are *Ascaris* and *Heterakis*. All the Ascarides live in the intestines—and especially in the small intestine—of various vertebrata.

2. OXYURIDÆ.—'The body is cylindroïd. The mouth is *nude, or surrounded by three slightly salient lips.* The œsophagus is long, with a *very distinct bulb or ventricle.* The males have *one spicule,* and two pairs of pre-anal papillæ, one of which generally occupies the side of the anus. The females, the caudal extremity of which is elongated and subulated, have always two ovaries, and the vulva ordinarily opens towards the anterior part of the body. Oviparous. Ova ovoïd, with a very resisting shell' (Railliet). Genus *Oxyuris,* a parasite of the intestines—and especially of the large intestine—of the domesticated Mammalia.

3. STRONGYLIDÆ.—'The body is cylindroïd, and rarely filiform. The mouth is *sometimes nude, sometimes furnished with papillæ, and at times provided with a chitinous armature.* The œsophagus is more or less enlarged posteriorly. The males possess an entire or divided *caudal pouch,* with *one or two spicules of equal length.* The females have one or two ovaries; the vulva is situated sometimes anterior to, at other times behind, the middle of the body. The Strongylides are oviparous or ovoviviparous' (Railliet).

This family comprises numerous genera that Railliet has divided into three tribes, basing the division chiefly on the presence or absence of the buccal armature, and on the form of the caudal pouch of the male. These are: 1. **Eustrongylines,** with mouth destitute of chitinous armature, and caudal pouch without ribs or bands—genus *Eustrongylus;* 2. **Strongylines,** the mouth likewise unarmed, and the caudal pouch sustained by ribs or bands—*Strongylus;* 3. **Sclerostomines,** the mouth furnished with a more or less complex chitinous armature, and the caudal pouch provided with ribs—*Œsophagostomum, Syngamus, Globocephalus, Sclerostomum, Stephanurus, Anchylostomum, Ollulanus, Hystrichis, Physaloptera.* Only the genera *Eustrongylus, Stephanurus,* and *Syngamus* are not parasites of the digestive canal.

4. TRICHOTRACHELIDÆ.—Worms of medium size, body very slender, tapering at great length in the anterior portion, which only contains the œsophagus—the posterior part lodging the intestine and genital organs. The mouth is rounded and nude; the œsophagus is very long. The males have a single spicule, which is envaginated, or presents two caudal papillæ. The females have a single ovary; the vulva is carried to the anterior quarter of the body, or to the origin of the enlarged part. These Worms are oviparous—*Trichocephalus* and *Trichosomum*—or ovoviviparous—*Trichina.* All the species of Trichocephalus live in the intestine; the majority of the species of Trichosomum are met with in the digestive tube; the Trichina is an intestinal parasite in the adult state.

5. FILARIIDES.—'The body is long and filiform. The mouth is of variable shape, sometimes encircled by lips, and even succeeded by a buccal capsule; it is often provided with papillæ. The œsophagus is small, and does not form a distinct ventricle. The males—the tail of which is generally rolled up—have a *single spicule or two unequal spicules.* The females have a double ovary; the *vulva* is usually situated *towards the anterior part of the body.* A great number of these Helminthes are ovoviviparous' (Railliet). Genera *Filaria, Spiroptera, Dispharagus,* and *Tropisurus.* The first two alone furnish intestinal parasites. The two others are met with among the Helminthes of the œsophagus or stomach of Birds.

6. GNATHOSTOMIDÆ.—This family is established by the only genus *Gnathostomum* (Owen), or *Cheiracanthus* (Dies), represented by *polymyarian* Nematodes, the cylindroïd body of which is covered in front by chitinous leaves or plates that have their posterior border notched into spinules; in the middle region, the leaves are simple and conical; the posterior part of the body is unarmed. 'Head distinct, globular, and studded with simple spines. Mouth with two lips—one dorsal, the other ventral. *Males* have a spiral tail garnished with papillæ below. *Females* have a straight tail; ovary double; vulva posterior. Oviparous' (Railliet). The Gnathostomes are parasites of the stomach, either of the Pig, or of the Dog and wild Cat.

7. ANGIOSTOMIDÆ.—'This family—not well characterized—comprises the Nematodes with filiform bodies, their mouth being small, and succeeded by an *œsophagus that nearly always shows a double enlargement.* The males have two equal spicules' (Railliet). Genus *Strongyloides*, of which the species live as parasites in the intestine of Man, the Sheep, Pig, and Rabbit.

In the following chapters, we shall take advantage of the tendency to localization, which is general in these parasites, and study them by passing in successive review each part of the digestive apparatus and its annexes.

CHAPTER I

PARASITES OF THE MOUTH AND PHARYNX

THE parasites which may be met with at the entrance to the digestive passages are somewhat numerous. There are usually found in the fluids of the mouth and pharynx various Fungi and Schizomycetes. But we cannot recognise their pathogenic *rôle* as they are nearly always present in these fluids; and when they appear to be abnormally abundant, this would seem to be due to inherent pathological conditions in their host. We have no occasion therefore, to notice them. The only vegetable parasite of the mouth that induces morbid phenomena is the *Saccharomyces* (*Oidium*) *albicans*, which causes *thrush* (*muguet*).

With regard to the animal parasites, we can scarcely cite more than the Sporozoa, the larvæ of the Gastrophilus, the Hæmopis, and the Spiroptera scutatum, which is found in the lingual and pharyngeal mucous membrane of the Pig, and will be alluded to when dealing with the parasites of the stomach of Ruminants. The Hæmopis usually has its abode in the mouth and pharynx, and its study should naturally be made here. The little that has to be said about the larvæ of the Gastrophilus will be more advantageously treated *à propos* of the parasites of the stomach of Equidæ.

ARTICLE I.—**Hæmopis.**

The **Hæmopis** or **Horse-leech** (*Hæmopis sanguisuga* Bergmann)—also named *Vorax*—is an Annelid belonging to the family GNATHOBDELLIDÆ of the sub-class *Hirudinea*, in which are also found the Leeches proper (*Hirudines*).

The Leeches have an elongated body, gradually contracted in front, widest in the middle, obtuse behind, flat on the inferior surface, semi-depressed on the upper surface, somewhat soft and viscid, very retractile and extensible, and composed of 95 to 97 rings (or segments). Each of the extremities is terminated by a sucker turned towards the ventral surface. The anterior, or *oral* sucker is slightly concave, and shaped like the beak of a flute. At its centre is the mouth, an opening in the form of a three-rayed star, an anterior median, and two lateral. Each of these slits permits the passage of a jaw—a semi-lenticular body with an adherent rectilinear border, which is continued by a kind of handle fixed in the musculo-cutaneous envelope, and a free convex border that carries a series of denticules in the form of transverse chevrons,

by means of which the Leeches perforate the integument. The eyes are ten in number, and are scarcely visible; they form a curved line at the anterior border of the dorsal surface. The posterior, or *anal* sucker, is twice as large as the oral one, and on its upper surface is a small opening—the anus.

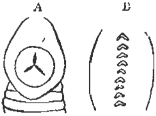

FIG. 124.—A, oral sucker of the Leech; B, some denticules of a jaw.—Carlet.

The Leeches are androgynous. The sexual organs appear towards the anterior third of the ventral surface. The vulva is a transverse slit, situated five rings behind the male orifice, or between the twenty-ninth and thirtieth rings of the Hæmopis. The Leeches are reproduced by reciprocal fecundation; two individuals approach each other by their ventral surfaces and in opposite directions, each playing at once the part of male and female. After fecundation—and during the twenty-five to forty days that precede ovulation—there is formed around the part of the body where the sexual organs are situated, an olivary enlargement that has received the name of *girdle*. At the moment of ovulation, the Leeches leave the water and bury themselves in damp ground. The glands in the girdle secrete a viscid substance, that soon becomes a membraneous capsule in the form of a funnel. The Leech crawls backwards out of this covering, after having laid an average of ten to eighteen eggs. The two openings in the capsule then close, and this, in drying, becomes brown, and assumes the appearance of a spongy *cocoon*. Each Leech produces one or two cocoons, rarely three; incubation occupies from twenty-five to twenty-eight days, and at the end of this period the young filiform leeches traverse the cocoon, leaving it at different points, though taking refuge in it again when any danger threatens them.

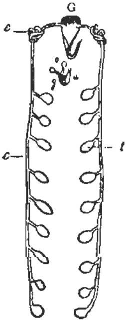

FIG. 125.—Genital apparatus of the Leech.—Carlet.

t, testicle; *c*, deferent canal; *e*, epididymis; G, pyriform vesicle; *o*, ovaries; *g*, albuminigenous glands; *u*, uterus.

With the *Hæmopis sanguisuga*, 'the back appears of a greenish-brown tint, inclining sometimes towards reddish or Sienna earth, at other times to olive or green; and generally there are longitudinal rows of dark, close-set, small points, more or less effaced—the rows being six in number, sometimes four, more rarely two. In some specimens these rows are replaced by one or two bands of a bright-red colour, darker on the borders; and in other individuals—much rarer—the back is altogether unicoloured. The borders are slightly prominent, and have a narrow band—orange, yellow, or reddish-brown in colour, rarely that of the back. The ventral surface is smooth, of a dark-slate colour, usually deeper than the back, sometimes slightly red or olive-tinted, and at other times dead-black; and in some specimens it is marked by faint, isolated, irregularly-shaped points' (Moquin-Tandon).

The variations of colour that the body may present, have been utilized by Moquin-Tandon to establish twelve varieties of the Leech.

The Horse-leech has often been mistaken for the medicinal Leech (*Hirudo medicinalis* Linn.); but it is easy, nevertheless, to distinguish them from each other.

While the medicinal Leech has well-marked rings, somewhat salient cutaneous glands, and possesses a certain rigidity—especially during its contractions, when it takes the shape of an olive—the Horse-leech is a little larger, is always very soft, and especially when the creature is elongated; its

skin-rings are also less marked, less coriaceous, and during contraction form less apparent ridges; while its cutaneous glands are smaller and less prominent. Besides, the medicinal Leech has the dorsal surface darker than the ventral, and is generally marked by six longitudinal, reddish bands, regularly or irregularly speckled with dark-brown spots; the ventral surface is yellow or olive-green, unicoloured or dark-spotted, with a wide black band on each side.

A very important characteristic is deduced from the form of the jaws. In the ordinary Leeches they are large—2 mm. or 3 mm. in diameter—and their denticules are very sharp, and about sixty in number. Those of the Hæmopis

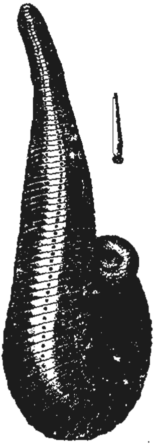

FIG. 126.—*Hæmopis sanguisuga*; natural size.—Railliet.

To the right of the figure is shown a young Leech found on the conjunctiva of a Horse.

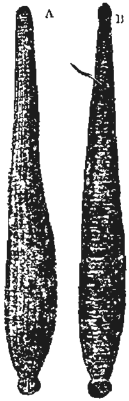

FIG. 127.—Medicinal Leech.

A, seen on the dorsal surface; B, seen on the ventral surface.

are scarcely 1 mm. in diameter, and are furnished with only about thirty not very sharp teeth. This difference in the jaws and teeth explains what Huzard the younger had already remarked—why the Horse-leech attacks only the mucous membrane, and not the skin, as the medicinal Leech does.

The *Hæmopis sanguisuga* has also been confounded with the black Leech, or Aulastoma vorax (*Aulastoma gulo* Braun).

The latter—which is often wrongly designated the *Horse-leech* in the neighbourhood of Paris—is smaller and less flattened than the Hæmopis. It is generally of a deep olive hue, almost black above, unicoloured, velvety, very rarely marked here and there with some small, irregular, and scarcely appreciable points; and sometimes shows on the margins of the body small

black, close-set points, but not a yellow or orange hem. The jaws are scarcely more than half a millimetre in diameter, and have only about fourteen very blunt teeth.

The Hæmopis lives in ponds, ditches, and small springs, and the adult usually lies at the bottom in mud. The young seem to prefer running water, keeping near the surface, and ready to throw themselves into the slightest current.

The *Hæmopis sanguisuga* is met with in nearly every part of Europe; it has been found in Sweden, but more especially in the South of Europe, in Portugal, and in Turkey. It is very common in North Africa—principally on the littoral, from Tunis to Syria. In Algeria, it has been seen by the French troops at every place they have reached—even in their most advanced marches into the desert; and is observed at all seasons, though it abounds most in water during the summer.

In consequence of the feebleness of its jaws, the Hæmopis—not being able to seize the skin—seeks to penetrate the natural openings, and fix itself on the mucous membrane. Man and the domesticated animals are exposed to its attacks.

It is found in Mankind in the mouth, pharynx, nasal fossæ, larynx, trachea, vagina, and on the conjunctivæ.

The domesticated animals it most frequently attacks are the Horse, Mule, Ox, and Camel; but there can be no doubt that all warm-blooded vertebrata are liable to its visitations, if they drink in places infested by it. Blaise has seen a Dog die from the action of eight Leeches, which fixed themselves in its pharynx; four of them belonged to the *Hirudino troctina*. Dr. Guyon—cited by A. Moquin-Tandon—introduced Leeches into the œsophagus and oviduct of several Fowls, and into the nasal fossæ and rectum of some Rabbits. The Fowls died from exhaustion in about thirty days, and the Rabbits in about forty days. Moquin-Tandon placed two large Horse-leeches in the pharynx of two young Rabbits; they entered the trachea, and caused death from asphyxia—one in three-quarters of an hour, the other in an hour and a half.

If the Hæmopis occupies a very extensive geographical area, the information relative to its action on the domesticated animals has been almost exclusively gathered in Spain and Algeria, and has been furnished by Fernando, Calvo, Blavette, Rodet, Forthomme, Lemichel, and Blaise.

The Horse-Leeches enter the mouth along with the drinking water, and they are usually young ones which are so taken by the domesticated animals—being filiform, and rarely longer than 2 mm. to 3 mm. They fix themselves inside the cheeks and lips, on the frænum of the tongue, on the palate, soft palate, and pharynx, and thence may reach the posterior nares, or enter the nasal cavities direct by the nostrils when the animals are drinking. They lacerate the mucous membrane by the denticules of their jaws, holding firmly to it by means of their oral and caudal suckers, become gorged with blood, and in doing so acquire a considerable size.

Their presence is easily recognised when once experience has shown the accidents they occasion; but to the inexperienced, these may remain for some time unobserved.

The signs of the action of the Leeches on some selected point of their *habitat*, are those of anæmia and slow internal hæmorrhage. The Horses become emaciated, gradually lose their appetite, and are soft, weak, and incapable of working; their hair is erect, the visible mucous membranes are pale, the limbs vacillate, and, notwithstanding every care, death supervenes if the cause of the trouble is not recognised. But this is often perceived by a more or less abundant flow of blood from the mouth or nostrils, and more especially during work. The Leeches, in fact, disgorge a portion of the blood they imbibe, and the wound they have produced also bleeds considerably when they quit it to fix themselves on another spot. When the Horse, Mule, or Ox is at rest it swallows the blood; but when at work, the bit in the mouth of the Horse hinders deglutition and often keeps that aperture open, allowing the blood to appear at the commissures, and to escape in a somewhat abundant stream at times.

The mouth is then explored, and the Leeches, if fixed in that cavity, can be seen. They are sometimes concealed behind the soft palate. If they are in the nasal cavities, blood will be noticed trickling from these, and the animal occasionally snorts, as if to expel the Leeches. Exploring the cavities by sunlight or a lamp will generally discover them. But as such accidents are rarely isolated, diagnosis is rendered easy by the analogy of the symptoms.

When the Leeches are in the pharynx or at the entrance of the larynx, they induce such intense dyspnœa that death may ensue from asphyxia.

The number of Hæmopis that may be found in one animal—during life or on post-mortem inspection—is extremely variable, and to it their obnoxious action is subordinate. Androvande states that nine of these Leeches are sufficient to kill a Horse; but observation proves this to be an exaggeration. Blaise reports that when he was at Constantine, Algeria, in the Bardo quarter, there was not a Horse or Mule which had less than nine adult Leeches hidden away in its nostrils, mouth, or pharynx, and he mentions two instances in which, at autopsies, he found 185 and 192 in two animals.

They are extremely tenacious, for Guyon has seen 27 still attached to the mucous membrane twelve hours after the death of an Ox which they had made their host; and Mégnin found, at Vincennes, some in an Ox from Algeria, which consequently must have harboured them for about eight days.

At the autopsy, in addition to the Leeches, there are usually remarked all the evidences of profound anæmia or asphyxia. The mucous membranes are œdematous, and more or less congested, as well as showing ecchymoses, which are traces of the bites.

It will be seen, then, that in certain countries—and particularly in Algeria—the Hæmopis is a veritable scourge. It causes serious

loss among Cattle, produces much debility among Dromedaries, and by its multiplication in the springs that supply the watering-places of several garrisons, it causes much trouble to the military authorities—rendering inefficient at the same time a number of Horses and Mules, and probably terminating the existence of some of them.

According to the observations of Blaise, the *Hæmopis sanguisuga* is not the only species that is to be dreaded as a parasite. In Algeria are to be found, under the same conditions, various species of Leeches that live in watering-places—such as the grey Leech (*Hirudo medicinalis* Linn.), the green Leech (*H. officinalis* Sav.), the trout or dragon Leech (*H. troctina* Johnson), etc.

In addition to the parasitic Water-leeches alluded to, there are numerous Land-leeches which attack the Horse, Ox, and other animals, besides Man. Among these, one of the most troublesome, perhaps, is the *Hæmadipsa Ceylonica* (*Hirudu tagalla*), which, as its name implies, is found in the island of Ceylon. It is only about an inch long, and is as thin as a knitting-needle ; but it is very active and bloodthirsty, pursuing its victim with rapidity, fastening itself on man or beast, and attaining a large size when satiated. It is entirely terrestrial, living amongst damp leaves and in the jungles during the dry season, and remaining more or less quiescent ; in the rainy season, however, it resumes its activity, attacking Men, Horses, Dogs, and other animals when they are passing through the woods and jungles, and even venturing out into the open ground, issuing from the grass and the dead leaves in troops. These cause much irritation and debility, from the numerous bites they inflict and the blood they extract, as well as the subsequent hæmorrhage. 'Horses are driven wild by them, and stamp the ground in fury to shake them from their fetlocks, to which they hang in bloody tassels. The bare legs of the palanquin-bearers and coolies are a favourite resort. As their hands are too much engaged to be spared to pull them off, the Leeches hang like bunches of grapes round their ankles ; and I have seen the blood literally flowing over the edge of a European's shoe, from their innumerable bites' (Tennent).

A similar form, and with like propensities, occurs at an elevation of 4,000 feet in the Philippine Islands, and others in Java and Sumatra ; and they have been met with at a height of 11,000 feet in the Himalayas. Land-leeches, with similar attributes, exist in Australia, Japan, and Chili (Fleming).

To detach Leeches from the mucous membranes, several measures are employed. When the creatures are accessible, they may be removed by means of forceps, or with the hand wrapped in a towel (Abou Bekr) to prevent them slipping through the fingers. Some people recommend their being clipped in two with scissors. Another way is to make repeated applications of vinegar or salts—common salt, sulphate of soda, alum, etc.—or merely to give fresh water to their victims ; but, unfortunately, it is not always easy to throw

these liquids into the pharynx, where the Leeches so often domicile themselves. Blaise has successfully employed fumigations of tar, tobacco, or juniper berries—repeated twice a day; the fits of coughing these provoke dislodge the Leeches, which are only slightly attached to the mucous membrane. Souvigny—cited by Blaise—employed an indiarubber sound, having on one end a piece of sponge; the latter was impregnated with ether, and pushed into the pharynx. Wine or brandy will suffice; but a solution of salt is the readiest, perhaps, at all times, and may be used for the pharynx, nasal fossæ, or any other parts with safety. For Land-leeches, the same applications may be employed for their removal from the skin; while their attacks on the limbs may be prevented by bandaging these with cotton, calico or any other cheap and convenient material.

When asphyxia is imminent, tracheotomy must be resorted to.

Animals should not be allowed to drink at places infested by Leeches; and when watered at a river or stream, in addition to being safe from their attack, if already invaded by them they are soon relieved, as the parasites when gorged with blood relinquish their hold of the mucous membrane as soon as they can resume their aquatic life. The Arab hippiatrist, Abou Bekr, recommends attaching a bag to the Horse's head, through which the water will be filtered when the animal is drinking, and through which the Leeches cannot pass. A piece of thick muslin or fine calico made into a nose-bag, and placed over the nostrils and mouth when the horse is about to drink, should answer the purpose. But the best course is to clear the watering-places of these pests, and to prevent their reintroduction.

Lemichel destroyed all the Leeches in the garrison reservoirs of Mustapha, by turning eels into them. Many other species of fish would fulfil the same office.

Perforated metal filters placed where the water enters, can only keep away the larger Leeches, as the smaller ones—owing to their tenuity—may pass through the openings. Blaise has obtained encouraging results with a filter made of powdered charcoal, packed and compressed, which arrested the Leeches; but the expense of this method has to be considered. Cauvet advises the use of a syphon-tube filled with fine sand, through which the water should be made to pass before it enters the troughs. This appears to be the most practical method of any.

CHAPTER II

PARASITES OF THE ŒSOPHAGUS AND STOMACH

In the stomach of the different domesticated animals, Worms may be found which come into it from the intestine—their ordinary *habitat*, and where they are agglomerated. These are more particularly the Ascarides and the Tæniæ.

Various Infusoria are more especially located in the œsophagus and stomach, as well as Trematodes.—*Distomum*, *Cephalogonimus*, and *Amphistomum*, Nematodes, and the larvæ of the Œstridæ; the latter are special to the Equidæ. The Nematodes—the majority of which are lodged in sub-mucous tumours in the œsophagus, stomach, or intestine—belong to four families only: Strongylidæ, Trichotrachelidæ, Filariidæ, and Gnathostomidæ (see p. 279). There are 1. In the Strongylidæ various species of *Strongylus*, *Ollulanus*, *Hystrichis*, *Physaloptera*. 2. In the Trichotrachelidæ, the *Trichosomum*. 3. In the Filariidæ, the *Spiroptera*, *Dispharagus*, and *Tropisurus*. 4. In the Gnathostomidæ, the *Gnathostomum*.

Of these diverse genera, only two—*Strongylus* and *Spiroptera*—have representatives in the œsophagus of a large number of Mammalia and Birds; the diagnosis of them may advantageously be dealt with here. The others being found in limited groups, it will be preferable to examine them when treating of the hosts in which they are found.

The **Strongyles** (*Strongylus* Müller) have the mouth nude or encircled by papillæ, and the œsophagus more or less abruptly dilated in its posterior part. The males have a caudal pouch usually bi-, tri-, or multi-lobular, and sustained by the ribs; there are two equal-sized spicules. The vulva is situated in the posterior moiety of the body.

The **Spiropteres** (*Spiroptera* Rud.) have an elongated body, though it is much less so than that of the Filariæ, from which, otherwise, they differ but little except in their *habitat*; the tail of the males is rolled up in a spiral manner, and furnished with membranous wings; there are two straight spicules; and the vulva is more or less distant from the mouth.

ARTICLE I.—Parasites of the Œsophagus and Stomach of Equidæ.

The only parasites which belong almost exclusively to the stomach of the Equidæ are the Nematodes and the larvæ of the Œstridæ.

A. NEMATODES.—Four have been described: two species of Strongylus and two of Spiroptera.

1. **Strongyle of Axe** (*Strongylus Axei* Cobbold).—A small filiform worm, gradually enlarging posteriorly, mouth nude; the male is furnished with three (?) unequal spicules, and is 6 mm. long, the female being 8 mm. The tail of the latter is abruptly contracted to a narrow point, and is conical. This Worm was found at the Royal Veterinary College, London, in tumours of the gastric mucous membrane of an Ass. Its presence does not give rise to any appreciable symptom. It is evidently the same species as that which Mazzanti found at Pisa in the mucosa of the right sac of the stomach of an old horse, and which he described under the name of *Strongylus tenuissimus*.

2. **Spiroptera megastoma** (Rud.).—Body whitish, and equally attenuated at both extremities. The cephalic portion is separated from the remainder of the body by a constriction, and is provided with four thick, horny lips, the

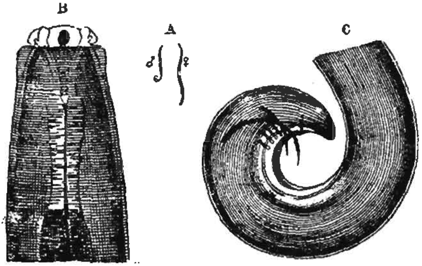

FIG. 128.—Spiroptera Megastoma.—Railliet.

A, male and female, natural size; B, cephalic extremity, lateral view, magnified 100 diameters; C, candal extremity of the male, lateral view, magnified 50 diameters.

two lateral of which are small, one dorsal and another ventral being broader, the two latter bearing a papilla on each of their lateral borders. The mouth is continued by an infundibuliform pharynx. *Male*: 7 mm. to 9 mm. long; tail obtuse, rolled in a spiral manner, and bearing two lateral wings, each sustained by four pre-anal and one post-anal papillæ; two unequal spicules. *Female*: 11 mm. or 12 mm. long; tail straight and obtuse; vulva situated towards the anterior third of the body. Ova oblong, almost linear, and hatched in the body of the female.

The Spiropteral tumours are usually found in the right sac of the stomach of the Horse. They form round prominences, the volume of which varies from that of a small nut to a fowl's egg. Their colour does not differ from that of the adjacent parts, and they are firm in consistence. They have on their summit one or more perforations that communicate with the irregular cavities into which they are hollowed. By pressure on these tumours, a greyish matter, as well as the worms they contain, is extruded.

These tumours are situated between the mucous and muscular layers of the stomach, and are the product of the irritation set up in the submucous connective tissue by the worms. Andral considered them as due to a pathological dilatation of the glands of the stomach, the orifices of which correspond to their perforations, and have served for the entrance of the Spiropteres; while Ercolani more correctly imagined that these perforate the mucous membrane, in order to introduce themselves beneath it.

When the tumours are old their contents are concrete, their walls have become fibrous, and they have the consistence of carti-

FIG. 129.—Spiropteres and larvæ of the Œstrus in the Stomach of a Horse.—Railliet.

Sp, Tumours of the *Spiroptera megastoma* developed in the right sac; O, orifices of these tumours; L, larvæ of the *Gastrophilus equi* fixed on the mucous membrane of the left sac; A, alveoli of insertion of the larvæ of the *Gastrophilus hæmorrhoidalis*, which have left the stomach (one-half the natural size).

lage. In them are found dead worms or their débris, or purulent matter if the worms have evacuated them for a long time.

Valenciennes found these verminous tumours in 11 Horses out of 25. They were most frequent in the month of June; and Ercolani made the same remark. The mode of introduction of these Spiropteres is not known, nor yet whether they multiply in the tumours or submit to migrations.

The presence of these tumours does not seem to cause any disturbance in the functions of the stomach, but they might hinder the passage of the alimentary matters if they were in large numbers in the vicinity of the pylorus (Railliet).

3. **Spiroptera microstoma** (Schn.).—This differs from the preceding species by its greater size—male, 10 mm. to 12 mm.; female, 12 mm. to 17 mm.—by the absence of the constriction behind the cephalic extremity; only two lateral lips in the form of a hatchet; two unsymmetrical post-anal papillæ on each side of the male. The ova are hatched in the uterus of the female.

C. Baillet has often found these Worms, in somewhat large numbers, in the stomach of the Equidæ. When that organ is examined immediately after death, its contents appear to be affected by a very pronounced undulatory movement, due to the action of these entozoa in every direction. They sometimes have the head engaged in the glands of the mucous membrane in the right sac. Railliet has on several occasions, in summer, observed extensive ulcers on the gastric mucous membrane of Asses killed at the Alfort Veterinary School, which were the hosts of large numbers of these parasites.

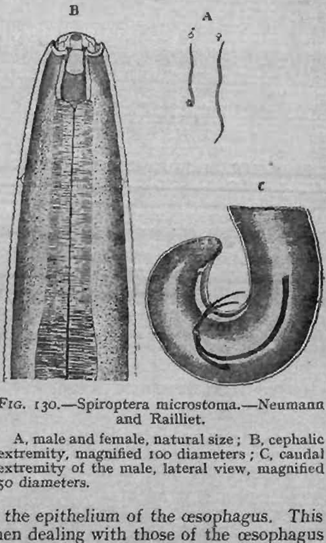

FIG. 130.—Spiroptera microstoma.—Neumann and Railliet.

A, male and female, natural size; B, cephalic extremity, magnified 100 diameters; C, caudal extremity of the male, lateral view, magnified 50 diameters.

Müller has found in an old Horse the *Gongylonema scutatum* lodged in the epithelium of the œsophagus. This parasite will be noticed when dealing with those of the œsophagus of the Ox and Pig.

B. LARVÆ OF THE ŒSTRIDÆ.—The most common parasites of the stomach of the Horse are the larvæ of the Œstridæ. By reason of their *habitat*, they constitute the gastricolæ, and all belong to the genus **Gastrophilus** (Leach), the result of doubling the genus *Œstrus* of Latreille.

FIG. 131.—Wing of the *Gastrophilus equi*, magnified 5 diameters.—Railliet (inedited).

Brauer has described eight species of Gastrophilus, the majority of which have been found in the larval condition in the stomach of the Equidæ.

1. *Gastrophilus equi* Fabr., a common species in Europe and North America.

2. *G. hæmorrhoidalis* Linn., spread throughout Europe and North America.

3. *G. pecorum* Fabr., common to Europe.

4. *G. nasalis* Linn., found also in Europe and in Nova Scotia.

5. *G. flavipes* Oliv., the larvæ of which inhabit the stomach of the Ass in Southern Europe and North Africa.

6. *G. inermis* Brauer, an Austrian species, the larva of which is unknown.

7. *G. lativentris* Löw, found in Russia; its larval life has not been ascertained.

8. *G. nigricornis* Löw, inhabits Bessarabia.

We have only to consider the first five species.

1. **Gastrophilus of the Horse** (*G. equi* Fabr., *Gastrus* or *Œstrus equi*, the Breeze or Horse-bee of Britain).—A woolly insect with a fawn-coloured face, covered with a white silky down; forehead fawn-coloured, the posterior part having black hairs; antennæ rust-coloured; thorax sometimes entirely covered with reddish hairs, and most frequently having a black transversal

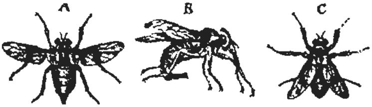

FIG. 132.—*Gastrophilus equi*, natural size.
A, female, dorsal view; B, the same in profile; C, male, dorsal view.

band. The abdomen is of a yellowish-brown or ferruginous tint, with irregular denticulated, brownish-grey, and more or less dark spots. The wings are transparent, and have in their middle a transverse smoky band, their posterior extremities having two points of the same tint. The posterior extremity of the male is obtuse; but the abdomen of the female is, on the contrary, extended as a long oviscapt, which is doubled under that region when at rest. Length—not including the oviscapt of the female—12 mm. to 14 mm.

This species is the most important of those we have to describe. It is found throughout Europe, and also in Africa—Egypt, Nubia, Cape of Good Hope—in Asia, and in North America. Macquart states that it is likewise found in the Canary Islands. It is less common in Britain than on the Continent of Europe.

It exists in the perfect state from June until October, but particularly in August. During the warmest hours of the day, the female flies buzzing about Horses, Asses, and Mules, balancing itself with the oviscapt directed downwards and forwards; it hovers for a few seconds over the place where it seeks to deposit its eggs, drops an egg upon it, and immediately flies away; but it soon returns, lays a second egg, and repeats the operation so often that hundreds of eggs may be found on the same Horse, which does not appear to be disturbed by the performance. The ova are observed

on various regions, but the insect prefers the anterior limbs—particularly the fore-arms—and the knees and shanks, parts most accessible to the Horse's tongue.

The ova of the Gastrophilus of the Horse are yellowish-white in colour and conical in shape, being 1·25 mm. long; they are transversely striated, and provided at the larger extremity with an operculum, which is obliquely truncated. They adhere to the hairs by their narrow end, in the same manner as the 'nits' of the Louse, by means of a viscid matter that is deposited with them; their wide end remains pendent. They are hatched in a few days—4 or 5 according to Bracy-Clark, 20 to 25 according to the observations of Joly; the operculum becomes detached, being pushed up by the larva, which is very vivacious, and begins to crawl on the skin, causing a slight itching, which impels the Horse to lick the place. The larvæ in this way are introduced into the digestive apparatus, and the majority fix themselves on the mucous membrane of the stomach by means of their buccal hooks, the head plunged deeper and deeper into an alveolus that is formed under the influence of the irritation due to their presence. They subsist on the inflammatory products resulting from this small wound in the mucous membrane.

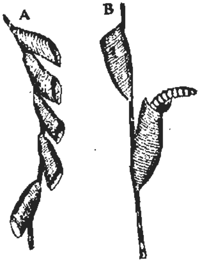

Fig. 133.—Eggs of the *Gastrophilus equi*, fixed on hairs. On the hair B is seen a larvule which has just been hatched.

On its exit from the egg, the larva (or 'bot') is very long and fusiform, and has thirteen rings or segments, the first of which are difficult to distinguish. The cephalic segment has two antennæ, two buccal hooks, a circle, and a fasciculus of movable spines—directed backwards like the hooks—and situated immediately in front of the second ring. Similar spines are present on the posterior border of the nine segments succeeding the first; but the last three segments are destitute of spines. The thirteenth segment has at its free extremity two lips, between which are projected—from time to time—two retractile tracheæ.

After the second moulting—the *third stage*—the larvæ are not so thick at their anterior extremity as behind, where the body is perpendicularly truncated. The integument is smooth and rigid, and does not readily wrinkle. There are only eleven segments, which are more convex on the dorsal than the ventral surface. The cephalic ring has—behind the antennæ and the buccal organs—several series of spinous prominences which are very small and curved. From the second to the eighth inclusively, each ring has—towards the anterior border—a double row of spines, also directed backwards, those of the first row being much stronger than those of the second. The ninth has some smaller ones, but only on the sides, and the tenth has none at all, or only one or two. The inferior surface of each ring, from the second to the tenth included, presents at its anterior border a double row of spinescent tubercles. A short longitudinal ridge runs along each side of the body. The eleventh ring, posteriorly, has the respiratory slit, which is limited by two narrow but salient lips, the bottom being formed by the stigmatic plates,

which are united into one by a common chitinous frame. Each plate is *reniform*, and constituted by three concentric arches, each having a longitudinal groove on which open small apertures arranged in pairs, which are the means of communication between the respiratory apparatus and the atmosphere. When the larva has reached maturity, these stigmatic plates are black; the spines are brown at the base and black at the points; the colour of the body—which was originally red—passes gradually to yellow; and the total length is from 18 mm. to 20 mm.

Maturity is attained after a sojourn of about ten months in the stomach of the Horse. From May to August the larvæ become

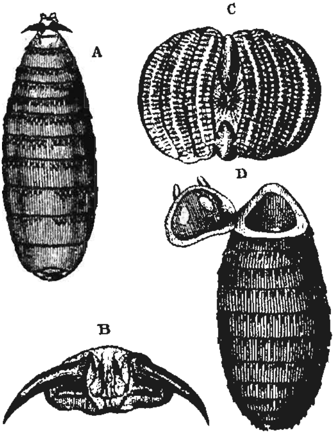

FIG. 134.—Larva and pupa of the *Gastrophilus equi*.

A, larva in the third stage, magnified two and a half diameters; B, its buccal apparatus; C, its posterior stigmatas; D, pupa, with its operculum; magnified 3 diameters.—Delafond.

detached voluntarily, and pass along with the alimentary matters to be finally expelled from the body of their host along with the fæces. According to the remark of Numan, although the larvæ are expelled at all hours of the day, yet the majority are evacuated during the night or towards the morning. At first very lively, they penetrate the ground or remain concealed in the excrements; then their movements cease, and they soon become rigid and motionless. After twenty-four to forty-eight hours they assume a bright-brown tint, then a dark-brown, almost black colour; the skin becomes hardened, and forms a shining shell (pupa-case) in

which the nympha is enclosed. This case or shell has a slight curvature from before to behind, the concavity of which is ventral.

The duration of the nymphosis is—as for the other Œstridæ—from about thirty to forty days, and the perfect insect (or *imago*) emerges according to the mode already indicated for all the forms of the family. Copulation takes place, and the females, in their turn, deposit their ova on the bodies of Horses.

2. **Gastrophilus hæmorrhoidalis** (Linn.).—Dark-brown colour; face covered with light-yellow hairs, forehead with fawn-tinted hairs; antennæ ferruginous. Thorax covered with olive-grey hairs in front of the suture, and showing a transverse black band behind it. Abdomen woolly, the hairs being white in front, black in the middle, and of an orange hue behind. Wings hyaline, without spots. Oviscapt as in the *G. equi*. Length, 9 mm. to 11 mm., without the oviscapt.

FIG. 135.

FIG. 136.

FIG. 137.

FIG. 138.

FIGS. 135 to 138.—*Gastrophilus hæmorrhoidalis.*

FIG. 135, female, natural size. FIG. 136, ovum; magnified 10 diameters. FIG. 137, larva in the third stage; magnified 2 diameters. FIG. 138, pupa, with its operculum; magnified 2 diameters.

This species is, with the *G. equi*, the most widespread in France. It is found throughout the whole of Europe and in North America; its habits are analogous to those of *G. equi*, though the female prefers to lay its eggs on the lips of the Horse, and the long hairs covering them. This gives rise to a kind of irritating tickling, which induces the Horse to rub its lips against the ground, the fore-limbs, or trees; or it seeks to evade attack by galloping away, and even plunging into water to escape from its enemy (Bracy-Clark).

The ova of the *G. hæmorrhoidalis* differ from those of *G. equi*, chiefly by their dark colour. The larvæ, at their exit, cause titillations, which compel the Horse to pass its tongue around its lips, and so the parasite is carried into the mouth, and thence into the digestive canal.

At the *third stage*, these larvæ, known in Britain as the red-tailed Horse-bot—mixed with those of *G. equi*—are distinguished by their slightly smaller size, their deeper-red colour, the spines of the first row of each anterior ring being scarcely so strong as those of the second, the presence of a denuded dorsal spot in the middle of the ninth ring, and the entire absence of dorsal spines on the tenth, as also on the eleventh ring.

They are also distinguished by their *habitat*, the sojourn they make in the rectum before returning to the external world, the greenish colour they assume, and certain other peculiarities in their parasitic existence which will be alluded to hereafter.

3. **Gastrophilus pecorum** (Fabr.).—The *male* is brown, and covered with tufted coppery-yellow hair, which is black in places. The segments of the body are short and spheroïdal; the thorax has, behind, a transverse band of black hairs, often interrupted in the middle by yellow hairs. The wings are small, of a fuliginous, greyish-yellow hue, and frequently showing a large smoky band in the middle, and a spot at the point. Length, 12·5 mm. The *female* is black or dark-brown, and covered with black or dirty-yellow hairs. The wings are shorter than the body, and are similar to those of the male or entirely fuliginous. Length, 15 mm.

The eggs differ little from those of *G. hæmorrhoidalis*. The larva, when mature, is 13 mm. or 14 mm. long, and is of a dark-red, blood tint; the spines are brown—bright at the base, and dark at the point. Their arrangement on the dorsal surface constitutes a distinctive character, being disposed in two rows on the anterior border of each ring, from the second to the fifth; at the sixth there is an interruption in the middle, which is still more marked in the seventh, and greater in the eighth, where it occupies the middle third of the ring. The succeeding rings are nearly always completely unarmed.

This species exists throughout Europe, and is very frequent—in the larval condition—among Hungarian Horses; it is very rare in Sweden, according to Boheman. Mégnin has seen perfect insects hatched from larvæ procured from Russian ponies sent to Paris.

Like those of the preceding species, the larvæ are fixed for some time to the rectum before being evacuated.

4. **Gastrophilus nasalis** (Linn.).—Insect covered with fine down. Upper surface of the thorax covered with dark hairs, intermixed with others of a golden hue. Dorsal scutellum shining, of a dark-brown, often of a fine, bright-brown, or golden chestnut colour. The abdomen is variable in colour, always garnished with long, fine, and close-set hairs, which are usually white on the second ring, black on the third, and orange on the succeeding ones; in others the latter are greyish, and in others, again, they are orange from the second ring. The wings are somewhat small, broad, and hyaline. Length, 12 mm. or 13 mm.

The ova are white, elliptical, truncated in front, and have on one side two longitudinal lines. An altogether distinctive feature of the larvæ is their having only *one* row of spines at the anterior border of their rings. On the upper surface the median interruption commences at the eighth ring; the tenth is unarmed. In a state of maturity, these larvæ are 13 mm. to 15 mm. in length, and are of a light-yellow colour; the spines are white at the base, and dark-brown at the point.

This species appears to be spread throughout Europe, but is most common in Austria and Prussia. It owes its name to the circumstance that the female deposits its eggs on the alæ of the nostrils and lips of the Horse. It has also been described by the name of *G. salutaris* Meig., *G. salutiferus* B. Clark, in order to signify the beneficial influence the larvæ are supposed to exert on the digestive functions.

They exclusively inhabit the pyloric region of the duodenum, and do not fix themselves to the margin of the anus while they are being evacuated.

5. **Gastrophilus flavipes** (Oliv.).—This is 11 mm. long, with pale-yellow legs and hyaline wings; the dorsal scutellum is black, with yellow lateral patches; abdomen of a shining brownish-yellow colour, with a darker longitudinal line; when pubescent, it is white. The larvæ are more especially parasitic in the Ass. The species is wide-spread in Dalmatia, Spain, Northern Africa, and Asia Minor; it is also found in the Pyrenees. Its history is still incomplete.

The larvæ of the **Gastrophilus elephantis** are found in the stomach of both the African and Asiatic Elephant, and are stated to be specifically different from those of the Horse, being sometimes one inch in length. Steel found that when these bots were removed from the membrane of the stomach they struggled violently, and several grasped his finger firmly with their hooklets. Cobbold thinks it not improbable that these larvæ are derived from the ova that have been deposited by the mature *Gastrophilus elephantis*, on the tusks of the Elephant. Another 'bot'—the *Pharyngobolus Africanus*—has been found in the pharynx of the African Elephant. No clinical importance has been attached to these larvæ.

FIG. 139.—Larva of the *Gastrophilus nasalis*, 3rd stage; magnified 2 diameters.—Railliet (inedited).

The larvæ of Gastrophilus are found in Horses which frequent pastures or live much in the open air, and which do not receive much grooming. The age, state of health or disease, and mode of feeding, have no influence upon them. According to the observations of Numan, these larvæ are much more abundant after dry, hot summers than after rainy seasons.

When taken into the mouth of the Horse by licking, the young larvæ do not all pass directly into the stomach; for it sometimes happens that some of them are arrested at the soft palate, on the epiglottis, and in the pharynx. This more especially, if not exclusively, occurs with those of the *G. hæmorrhoidalis*. Their presence is not altogether without danger. Vitry reports the case of a Horse which succumbed in two months to an affection characterized by a violent dry cough, and increasing dyspnœa that terminated in asphyxia. At the necropsy nothing could be discovered, except five larvæ of the Gastrophilus, attached to the margin of the epiglottis, their bodies floating in the larynx. Crepin has seen a Horse that presented analogous symptoms to the preceding, attended by a farrier, who, thinking a feather had got fixed about the larynx, introduced a rod with a piece of cloth at the end into the œsophagus. On withdrawing it he found several larvæ, and repeating the manœuvre several times, the Horse was cured. Gunther relates a similar case to the first, but there was more 'roaring'; and Renner states that the Russian empirics employ a brush with which to detach the larvæ that are fixed in the 'gullet.' Pigeaire has often witnessed similar instances among the Camargue Horses, several dying from asphyxia. The treatment adopted also consisted in introducing into the pharynx a stick enveloped in a towel impregnated with olive-oil, or, better, empyreumatic oil.

In general, the larvæ of the *Gastrophilus equi* fix themselves on the gastric mucous membrane, and almost exclusively in the left sac—occupying, by preference, the region adjoining the velvety

mucous membrane in the right sac—and some stop in the œsophagus, above the cardiac opening, where the membrane offers the same characters as in the left sac of the stomach. When the stomach of a Horse is opened, the larvæ are found in variable numbers—10, 15, 20, or more, sometimes even hundreds; Daubenton has counted more than 600, Vallisnieri 700, and Numan more than 1,000, in one stomach. They are collected in one or more groups, one of which is always larger than the other. There may be a mixture of several kinds of larvæ, though in our country those of the *G. equi* predominate They are more especially located in the left sac of the stomach, but those of *G. hæmorrhoidalis* —besides their possible arrest in the pharyngeal region—may also be found in the right sac and in the duodenum. They remain some time in the latter portions of the rectum before leaving the body, and there they assume a characteristic green tint. They can be seen at the time of defecation, when the rectum is everted; and it is this which gave rise to the error—pointed out by Bracy-Clark—that the larvæ of the *G. hæmorrhoidalis* are developed in this region: the eggs having been deposited there in the springtime by the female, which took advantage of the protrusion of the mucous membrane when the fæces were being expelled. The larvæ of the *G. pecorum* have also the same temporary lodgment in the rectum before emerging to undergo their nymphosis; but this does not occur with the *G. equi* or *G. nasalis*, the larvæ of the latter having the duodenum for the principal *habitat*.

With regard to the *effects* that these larvæ may have on the health, very divergent opinions have been given. Certain authorities have attributed the most serious consequences to them, and Numan cites a number who have asserted that the larvæ erode the tissues of the stomach, perforate it, and in this way cause death; or they bring on emaciation, or induce cough, colic, cerebral symptoms, or inflammation of different viscera, and especially the lungs. Chabert lays the most varied maladies to their account; while Vallisnieri ascribes an epizoöty, which killed a great number of Horses in 1713, at Verona and Mantua, to the enormous quantities of larvæ generally found in the stomach (Numan). From a careful examination of the majority of the cases reported, Numan concludes that the perforations observed were produced after death, and that they were easily effected because of the ante- and post-mortem softening of the tissues of the stomach.

It is true that, when we reflect on the extreme frequency of the gastric larvæ, the numbers of Horses which are infested with them, and the impossibility of even suspecting their presence during life, owing to the absence of any apparent disturbance, we might be led to consider these parasites as altogether inoffensive. Some authorities have ascribed a stimulant action to them, which is of advantage to the digestive functions; but in this there is manifest exaggeration. We cannot admit that the numerous ulcers produced on the surface of the œsophageal and gastric mucous membrane

are a matter of absolute indifference, and, indeed, they must have some effect on the function of these organs, which ought to be revealed when other pathological conditions intervene. In any case, a considerable number of observations are recorded of fatal troubles having been due to these larvæ; and we have quoted some of a relatively recent date, and altogether independent of any preconceived ideas which Numan's observers may have entertained.

Numan reports having once found the duodenum pierced by four or five holes, evidently due to the larvæ of the Œstrus, one of which had passed through a hole and was attached to the peritoneum; another was firmly fixed in a second perforation, and several had bored through the mucous and muscular tunics, leaving the serous membrane intact. There was inflammation and manifest softening of this portion of the intestine. The Horse had suffered for a long time from a disease of the foot, and died from exhaustion. The larvæ were those of the *Gastrophilus nasalis*. Numan also states that the Royal Veterinary College of London has the stomach of a two-year-old colt, which presents at its larger curvature and inferior surface a considerable thickening, in the centre of which are six perforations through all the gastric tunics, and in which are many larvæ of the Œstrus; while three or four perforations have no larvæ, and about fifty of the parasites are still adherent to the internal surface of the stomach.

At the autopsy of an aged Mule, which had shown all the symptoms of chronic gastro-enteritis, Delamotte discovered four perforations of the stomach —which were attributed to these larvæ—that led to a large diverticulum formed by the peritoneum, which was separated from the organ, and in which alimentary matters had accumulated.

The presence of larvæ of the *G. hæmorrhoidalis* and *G. pecorum* in the folds of the rectal mucous membrane has sometimes occasioned troubles that have not always been without gravity.

Hertwig reports having observed a Horse which, in consequence of the presence of some thirty larvæ in the rectum and anus, made such violent efforts at defecation that there occurred an eversion of the rectum, which required a surgical operation to reduce it.

The *lesions* caused by the larvæ of the *Gastrophilus equi*—other than the perforations just discussed—are those of a gastritis, ordinarily very slight, and even inappreciable. The more constant are ulcerations involving the mucous membrane of the left sac, and distributed as are the larvæ themselves, of which they in reality indicate the points of fixation. They are in the form of circular sores, from 4 mm. to 5 mm. in diameter, rose-coloured in the centre, borders salient, and several of them sometimes running into each other. In a two-years-old colt, Lafosse found a larva lodged in the connective tissue beneath the parietal layer of the peritoneum. We need not now speak of those sometimes observed in the cranium, as they will be referred to when treating of the parasites of the brain.

The *prophylaxis* consists in preventing animals being reached by the winged Insect, by adopting the measures already indicated, p. 34, and more especially having them frequently and attentively groomed.

In the *treatment*, the object must be to kill the larvæ in the

stomach, without injuring the health of the host. Lessona says he has obtained the greatest success with bryonia-root—15 to 25 grammes—powdered and given in half a litre of water. Cambron gives the preference to tar—in doses of 8 to 40 grammes—in an aromatic infusion; it may be useful to repeat it. Iodine tincture and benzine may also be recommended.

But an easy cure must not be relied upon, as the majority of authorities confess to having failed in the employment of diverse agents. From all the serious attempts made before him and by him, and numerous experiments—which consisted in plunging the larvæ in toxic fluids or in irrespirable gases—Numan arrived at the conclusion 'that agents endowed with great energy, which arrive in the stomach without undergoing any modification, act upon that viscus, but scarcely produce any effect on the larvæ. No medication can therefore be recommended for their destruction or expulsion.' It is fortunate that their sojourn is only temporary, and that they are eliminated spontaneously when the summer returns. Therefore, as a cure should occur spontaneously, without any medication, there is no necessity to intervene unless the health is seriously compromised. Should this happen, then mucilaginous fluids may be given to allay the irritation in the stomach; a substantial alimentation ought also to be enjoined, to compensate the loss of nutriment incurred by the presence of the 'bots.'

It is, nevertheless, advantageous to remove by the hand the larvæ of the *G. hæmorrhoidalis* and *G. pecorum* which appear on the rectal mucous membrane and at the margin of the anus, and so relieve the Horse from an annoyance that is sometimes dangerous. It may also be advisable, in certain cases, to introduce the hand and arm into the rectum in order to ascertain whether any have arrived there, or to administer enemas of salt or soap and water, a weak emulsion of petroleum or of benzine, or a dilute solution of creosote. We have seen above how the larvæ fixed in the pharynx and larynx should be removed.

ARTICLE II.—Parasites of the Œsophagus and Stomach of Ruminants.

There may be found in the œsophagus and stomach of Ruminants Infusoria, Coccidia, Trematodes, and Nematodes.

INFUSORIA.—The rumen and reticulum of Ruminants contain—suspended, and swimming in the midst of the semi-fluid mass of food—inferior vegetable or animal organisms. The first do not offer anything particular for comment, as they are found in all liquids in which vegetable matter is macerating, and the majority of them belong to the great group of Schizomycetes. The second are the **Ciliate Infusoria**, *Holotricha* and the *Peritricha*.

The Infusoria met with in the first two gastric compartments of Ruminants only live a short time in their host, because of the chilling and the alterations taking place in their liquid medium.

Fiorentini says they only appear after suckling, when the Ruminants are fed exclusively on vegetable matters. They are digested, and pass into the true stomach and intestines. Their number is so great that Gruby and Delafond estimated the total weight of those found in the first two compartments of the stomach of a Sheep at 600 to 1,000 grammes. They are certainly not parasites, but only commensals; and it is possible that they have a share in the digestive process of Ruminants, as Certes has noticed the presence of glycogen in the protoplasm of these animalcules.

COCCIDIA.—In 70 per cent. of the Sheep examined at the Abbatoir of Lubeck, Maske found in the mucosa of the abomasum some prominent grey nodules of the size of a pin's head situated in the depth of the mucous folds, which sometimes were strewn with them, and sometimes presented only a few. Lodged directly under the epithelium between the gastric glands they were limited by a vitreous zone formed by the mucosa. The internal part of the nodules was constituted by nucleated coccidia in various stages of development.

This coccidium very probably is the same (*Coccidium Faurei*) as that which has been found several times in the small intestine of the sheep.

FIG. 140.—Fragment of the rumen of a Cow, showing the conical Amphistomum fixed between the papillæ by the large posterior sucker. The insertion tubercles of several which have been removed can be seen. Natural size.—*Railliet.*

TREMATODES.—Two species of Amphistomum have been described as living in the rumen of the domestic Ruminants. One is the **Amphistomum crumeniferum** (Creplin), found in the Zebu (*Bos Indicus*); the other is the **Amphistomum conicum** (Zeder), which lives in the Ox, Sheep, and Goat, and possesses some interest.

Amphistomum conicum is ovoid, thin in front, gradually thickening to the posterior part, which is obtuse and a little curved on the ventral surface. The colour of the body is rosy, irregular, and more or less dark. Length, 10 mm. to 13 mm.; breadth posteriorly, 2 mm. to 3 mm.

Daubenton was the first to find this worm in the rumen and reticulum of the Ox. It has since been met with in the Sheep (Treutler), Goat (Creplin), and a considerable number of wild Ruminants. It fixes itself—by means of its posterior sucker—between the papillæ of the rumen, and more especially to the borders of the œsophageal furrow. It appears to be most frequently present in the month of April, and has been considered inoffensive; but Zürn states that a deadly disease of cattle has been attributed to it in Australia, though doubtless this is only a coincidence.

This parasite is very common in Egypt. To this species may belong the cercaria of the Amphistome found at Cairo, by Sonsino, on a Gasteropod (*Physa Alexandrina*). This is a cercaria which forms cysts and fixes itself everywhere—on aquatic plants, stones, shells of Molluscs, etc.

NEMATODES.—Several species of strongylus and one of Spiroptera are, in different degrees, parasites of the stomach or œsophagus of Ruminants.

Strongylus cervicornis (McFadyean).—This nematode was found by McFadyean when investigating the cause of an alarming number of deaths

—5 to 20 per cent.—among lambs in Lincolnshire and other parts of England in the autumn of 1896. From his report to the Royal Agricultural Society on these outbreaks of parasitic gastro-enteritis in lambs we take the following:

'As is the rule with parasites of this kind, the males are less numerous and smaller than the females. The common length of the latter is about two-fifths of an inch, and of the males about three-tenths of an inch. The largest females met with were half an inch long. The mouth is unarmed, and behind it the body gradually increases in thickness as far as the vulva in the female, and to the posterior extremity in the male. On each side of the fore part of the body or neck there is a barb-like papilla. The skin has fine transverse rings, and it is also provided with longitudinal ridges, of which there are eight to ten on each aspect of the body (upper and lower). The vulva is distant about one-sixth of the total length of the body from the tail, and it is covered by a cutaneous flap-like appendage. The degree of development of this appendage varies a good deal in individuals of the same size, and it is sometimes rudimentary or absent. The tail is pointed and slightly curved. The alimentary tube takes a nearly straight course through the body, and is not intertwined with the uterus. The uteri, which are directed forwards and backwards from the vulva, contain a large number of obliquely placed oval eggs of relatively large size. Those nearest the vulva are in the morula stage of division or already show the form of the embryo. The eggs nearest the vulva measure about ·09 mm. in their long diameter, and their greatest transverse diameter is about ·05 mm.

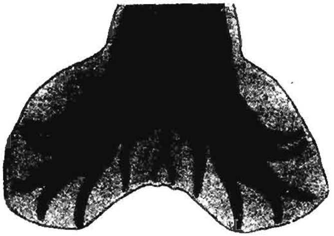

FIG. 141.—Caudal extremity of male *Strongylus cervicornis* magnified.—McFadyean.

'The male worms have a bursa which is somewhat difficult to spread. When expanded it has the outline shown in Fig. 141. The posterior rays spring from a long common median stem, and each is itself branched, the whole bearing some resemblance to a stag's horn. The spicules are about 0·24 mm. long in a worm 8 mm. in length, and they are longitudinally divided at their posterior extremities. On the assumption that the worm belongs to a species not previously described, the name *Strongylus cervicornis* (from the shape of the posterior rays of the bursa of the male) is suggested for it.

'With the adult worms numerous eggs were sometimes found in the stomach contents, but neither free embryos nor larger sexually immature worms were found in the stomach. What is the precise stage of development at which the worms are taken in is therefore unknown, but the fact that intermediate forms between the embryo and the adult were not met with would seem to indicate that adult size and sexual maturity are very soon attained after the parasite has entered the stomach. The eggs or liberated embryos are doubtless passed out with the fæces, to undergo a phase of development in soil or water.

'These worms are so small that they may easily be overlooked if the person making the post-mortem examination relies upon naked-eye inspection of the fourth stomach and its contents. Even when present in thousands in the muddy contents of the stomach it is impossible to detect them with the naked eye unless a very thin stratum of liquid is examined, but they may easily be made out when a little of the contents or a scraping from the lining

membrane of the stomach is suspended in water and examined in a flat-bottomed glass dish. When taken from the stomach of an animal recently dead they display active movements, but when putrefaction of the carcass sets in they soon die and shrivel up. In the perfectly fresh stomach they are generally most numerous on the lining membrane, but even then they may be present in hundreds in the liquid contents. If some time has elapsed since the animal's death the worms are generally in greatest numbers in the stomach contents.

'A knowledge of the symptoms was gathered from the reports furnished by veterinary surgeons who forwarded animals or viscera for examination, and from personal inspection of diseased lambs in three different flocks. The most constant symptom was scouring, and this was seldom or never absent in animals in which the illness lasted for a few days. The diarrhœa was accompanied by rapid wasting, and by loss of appetite. Abnormal thirst was frequently noted, and in some cases the lambs displayed an inclination to lick sand or earth. This morbid propensity appeared to have been present much more frequently than it was noticed during life, for the presence of sand and earth in the stomachs was very generally found at the post-mortem, although in most cases the lambs had been on grass.

FIG. 142.—Caudal extremity of male *Strongylus contortus* magnified. (After McFadyean).

'The temperature was generally above the normal, varying from 105° to 108° F. Cough, as a rule, was not a symptom that had attracted the notice of owner or shepherd. In some cases the course of the illness was very acute, the animals dying within twenty-four hours; but, as a rule, the lambs were more or less ill, with the symptoms above described, for several days or weeks.'

Strongylus contortus (Rud.).—Body red or white—according as its intestine is or is not full of blood sucked from the mucous membrane—filiform or attenuated at the extremities. At a short distance from the anterior extremity are two small lateral papillæ, in the form of teeth directed backwards. Integument finely striated transversely, and showing, besides, from 40 to 50 longitudinal ridges. Mouth nude. *Male*, 10 mm. to 20 mm. long; caudal pouch bilobate, each lobe being sustained by four ribs, the middle and anterior being doubled; the right lobe has an accessory lobe supported by the two posterior ribs, which are short and slightly divided at their extremity. *Female*, 20 mm. to 30 mm. long, the body terminating in a pointed tail; vulva situated towards the posterior fifth of the body, at the bottom of a depression surmounted by a powerful linguiform appendage directed backwards. Eggs ovoid, from 70 μ to 97 μ long, and 43 μ to 54 μ broad.

The *Strongylus contortus* lives in the abomasum of the Sheep, Goat, Argali, and Chamois. Railliet and Lucet have found it in the abomasum of a heifer, and ourselves in that of a Cow. It subsists on the blood it abstracts from the mucous membrane, and to this it owes its brown colour. Its name is justified by the arrangement of its ovarian tubes, which are rolled around the intestine to form

regular loops, the white colour of which contrasts with the dark tint of the digestive tube.

According to the investigations of C. Baillet, the *Strongylus contortus* is ovoviviparous, and the rhabditiform embryos it produces will not develop in pure water, but die in the course of a few weeks. Leuckart has seen them grow rapidly in muddy water, however, and after several moultings reach a state of development in which they were capable of being completely perfected in Ruminants. It is therefore probable, that Sheep are infested by drinking water soiled by the excrements of animals which are bearers of the Strongyles.

This worm has only once been reported in France as a dangerous parasite; but in Germany, on the contrary, it has been considered by Gurlt, Gerlach, Röll, Zürn, etc., as causing an epizoötic disease—*Magenwurmseuche*—that often attacks more especially lambs and year-old Sheep, is often complicated with verminous bronchitis, and generally appears during the spring and summer, in certain countries with sandy soils where there is stagnant water. Similar observations have been made in England and Scotland. In the United States of America it also causes serious damage, to lambs and yearling sheep more especially. Stiles mentions an epizoöty in Pennsylvania, in which the parasites were so numerous that they concealed the mucous membrane of the abomasum.

It is a kind of *pernicious anæmia*, the symptoms of which are not very characteristic, and scarcely permit a precise diagnosis to be established; there are dulness, languor, inappetence, pica, intense thirst, emaciation, hydræmia, sub-acute colic, and black diarrhœa. The disease usually terminates in death Wernicke indicates—as an ante mortem sign—a peculiar alteration in the blood (*poikilocytosis*), which shows, mixed with the red corpuscles, reddish-yellow, isolated cells, larger than the normal globules, of which some are spherical, and others foliaceous, scutiform, pyriform, or claviform.

At the autopsy of animals which have been killed or have died, there are found in the abomasum hundreds, even thousands, of the *Strongylus contortus* lying close together on the mucous membrane, which is paler than usual, and may be also somewhat thickened; though in some instances it may be sanguinolent, and show numerous ulcerations where the worms are yet attached. The abomasum is more or less dilated, and contains reddish matters, also tinted by effused blood.

This strongylosis of the abomasum is only serious because of its epizoötic form, or if it has reached an advanced stage, or the animals have not been submitted to suitable treatment.

Tonics and strengthening food are recommended. The medicines employed are Chabert's empyreumatic oil—a teaspoonful per head every day; or a mixture of equal parts of empyreumatic oil and oil of turpentine, diluted with treble its weight of brandy—the dose being two teaspoonfuls a day; or even kamala—3 to 4 grammes per

day. Zürn, after Rabe, prefers, as less irritant and as active for the patients, the picrate of potash given daily in doses of ·15 to ·30 gramme to lambs, and 1·25 grammes to adults; a cure is effected in about three days.

In the treatment of lambs infested with *S. cervicornis*, McFadyean recommends ¼ pint of a 1 per cent. aqueous solution of lysol, and in similar cases Law has had abundant success with a powder composed of arsenious acid 1 drachm, ferrous sulphate 5 drachms, nux vomica 2 drachms, areca nut 2 ounces, common salt 4 ounces, mixed and divided into thirty parts, of which one is given daily.

PREVENTION.—Referring to the prevention of parasitic gastro-enteritis in lambs, McFadyean states: 'The strictly contagious and infectious diseases are spread by the transmission of their germs from the diseased to the healthy animals, and strongylosis of the abomasum is spread by the parasites which are produced in the stomach and intestines of an affected lamb being passed out with the fæces, and afterwards taken in with food or water by a healthy lamb. But between the two cases there is a very important difference, owing to the fact that the vegetable parasites or bacteria, which cause the contagious or infectious diseases—have unlimited powers of multiplication within the animal body, from which it follows that a single germ may suffice to infect an animal, and be the starting-point of a fatal attack. On the other hand, a single nematode worm, or even several, would have no appreciable effect on the general health of a lamb, because indefinite multiplication of the species does not go on within the body. A single impregnated female worm may produce thousands of eggs or embryos, but these do not develop into mature individuals within the body, or serve there as the starting-point of a new generation. They are passed out with the excrement, and afterwards at an unascertained stage of development they may find their way into the stomach of another lamb. From this it will be obvious that the parasites might be present in a flock for years without causing any deaths, and without setting up any symptoms of illness. Such might be the case if the flock had a wide range of pasture, as that would reduce the chances of the parasites voided by the infested animals finding their way in large numbers into the alimentary canal of animals then or at a later period grazing on the same land. But in proportion as the number of Sheep kept on a given area increased the chances of the re-entrance of the parasites with food or water would be multiplied, and a point might thus be reached at which the majority of the flock would come to harbour what may be called the pathogenic number of worms. Overstocking plays a most important part in causing the disease.

'It will be gathered, from what has been said regarding the life-history of the parasite, that fields on which a large number of lambs affected with the disease have been grazed are certain to be highly contaminated, and that lambs put to graze on such fields during the following season run great risk of infection.

'It has already been stated that the power of multiplication within the body is limited, as the eggs or young worms produced there are voided with the excrement. It is equally important to know that no reproduction at all takes place external to the body. The stages of development of this particular parasite in the outer world have not yet been followed, but from what is known of the life history of other nearly related species there need be little hesitation in accepting the statement just made. The eggs or liberated embryos become dispersed in the soil or find their way into water, and although they no doubt undergo a certain stage of development, they do not attain adult size or sexual maturity until they are taken into the stomach. Their powers of resistance must be sufficient to enable them to withstand considerable vicissitudes in respect of weather, but it is highly probable that they have a comparatively limited duration of life outside the body. It must be confessed that on this point we have no certain knowledge, but it appears unlikely that these sexually immature parasites can maintain their existence for years in soil or water, and hence even badly contaminated soil would probably become safe again if Sheep were kept off it for two or three years.

'In the absence of direct observations on the point, one can only speculate regarding the efficacy of such agents as lime or salt when applied to the land with the object of killing the worms, but if the parasites are anything like so resistant in their earlier stages of development as they are when full grown, it is difficult to believe that any chemical not absolutely destructive to the herbage could be relied upon to kill the worms in the soil.

'It is at present uncertain to what extent water is the vehicle by which the worms are taken into the stomach, but it would appear to be a wise precaution to keep lambs off land that has been flooded, to prevent access to stagnant ponds or ditches, and to provide well-water where a clear running stream is not available.'

Strongylus filicollis (Rud.).—This Strongyle may be found in the abomasum of the Sheep and Goat, alone or in company with the preceding. It is capable of causing grave damage; but as it usually inhabits more particularly the small intestine, it will be noticed when speaking of the parasites of that organ.

Strongylus vicarius.—This nematode was found by Stiles in the abomasum of Sheep in the Gulf States (U.S.A.). According to Law, this worm resembles *S. convolutus* from which it may be distinguished by its smaller size, and by the absence in the female of the bell-shaped tegumental fold or covering of the vulva. Its effects on the Sheep are similar to those produced by Ostertag's strongylus in the abomasum of cattle.

Strongylus convolutus (Ostertag) (*St. Ostertagi* Stiles).—Body yellowish-brown—darker in the female—filiform, and tapering at the extremities. Mouth nude; œsophagus separated from the intestine by a small bulb. The *male* is 7 mm. to 9 mm. long, and has the caudal pouch bilobate, each lobe being sustained by four ribs, the middle and anterior of which are doubled

the posterior ribs are short, a little divided at their extremity, and fused at their base, and join the two lobes of the pouch. The *female* is 10 mm. to 13 mm. long, and terminates in a short tail; the vulva is situated towards the posterior tenth of the body—that is, near the anus, and occupies the bottom of a depression above which is a kind of membranous bell.

Ostertag's description of this parasite may be given:

It is small, cylindrical-shaped, and provided with a strong chitinous envelope which is regularly transversely ringed. The colour is yellowish-brown, and the females are somewhat darker than the males. The colour is due to small pigment granules in the intestine.

The mouth is terminal, very small, and unarmed, being merely provided with a capsule-like thickening of chitinous envelope. The œsophagus is short, and its musculature strong; at the end of the œsophagus there is a slightly developed bulb. The intestinal canal is only slightly coiled. On either side of the commencement of the intestinal tract there is a peculiar glandular structure.

Length of the male, 7 to 9 mm.; of the female, 10 to 13 mm. Thickness, 0·12 mm. The caudal end of the male shows a beautifully formed membranous bursa, the diameter of which is 0·22 mm., while from the end of the body to the point of attachment of the bursa measures 0·16 mm. The bursa is supported by somewhat slender ribs with a facetted structure. Ribs 3 and 6 reach as far as the point of attachment of the bursa, while 1 and 2 and 4 and 5 are fused superiorly. The posterior ribs, at their hinder extremity, run out into two small points, and are provided with a lateral process.

The spicules are double, dark yellow in colour, and have a length of 0·2 mm. and a breadth of 0·02 mm. They lie in a sheath, and show at their anterior extremity a small knob-like swelling, while towards the bursa they divide like the claws of a fowl. At the latter place one observes also short spiny outgrowths.

The females are on an average larger, darker in colour, and more numerously present than the males. The ovarium is unpaired, and contains a single row of eggs or rudiments of ova. The ripe eggs have an oval shape; in the uterus they lie obliquely, the one behind the other, and they show commencing division of their protoplasm. No further stage of development than this was observed within the body of the worm. From the vagina a uterus branches off forwards and backwards; the length of the uterus is on an average 0·16 mm. The uterus shows repeated sacculations, and is provided with a funnel-shaped termination towards the ovary. The length of the vagina is 0·04 mm.; the vulva has a breadth of 0·04 mm., and opens outwardly with a funnel-shaped mouth.

The vulva is covered with a bell-shaped fold of integument (and this is regarded as one of the most characteristic features of the parasite). This fold has a length of about 0·2 mm., and its transverse measurement is the same. The anus is 0·16 mm. in front of the posterior end of the body. The tail ends in a slightly curved sharp point.

This worm was found in 1890 by Ostertag in the abomasum of the Ox, in variable quantity, in 90 per cent. of the cattle slaughtered in the Berlin abbatoirs. It was only in limited number in animals in good condition, but was abundant in those which were emaciated or otherwise in a low state. The mucous membrane of the abomasum was swollen throughout, and closely beset with small, circular, flat elevations of the epithelium, each of which showed a small pinhole opening at its centre. Microscopic examination of these elevations discovered the presence in each of a small round worm. Some of the parasites were not fully developed, but the majority were sexually mature, and both sexes were represented

Some time after slaughter, the worms left these nodules, and many were found on the surface of the epithelium, a large number projecting in various lengths from the orifices of the small tumours. Stiles has found this worm in Cattle and Sheep, in the United States and particularly in Texas, where every bovine animal—old or young—submitted to his examination contained representatives of Ostertag's strongyle in the mucosa of the abomasum (Law).

This parasite appears to be the cause of a pernicious anæmia, accompanied by catarrh of the abomasum and profuse diarrhœa, young animals being more particularly its victims. Affected animals rapidly lose flesh, and eventually succumb—when not slaughtered.

There is no satisfactory curative treatment, though in cases still in the incipient stage the disease may be checked and recovery promoted—if only for a time—by a varied course of anthelmintics and gastric antiseptics, conjoined with tonics, free access to salt, and attention to the condition of the food (or pasture) and drinking water.

The **Gongylonema scutatum** (Müller) is yellow; the mouth is round and nude; the cephalic extremity is truncated, and surrounded for the length of a millimetre by chitinous plates of various thicknesses, in the form of a shield. The *male* is 4 cm. to 5 cm. long, has the tail rolled up, and is furnished with two wings and two spicules. The *female* is 8 cm. to 10 cm. long, and has the vulva situated in front of the anus; it is ovoviviparous.

This species has been found by Müller, of Vienna, in the epithelium of the œsophagus—and more especially in its thoracic portion—in five Polish and Hungarian Oxen; he described it under the name of *Spiroptera scutata œsophagea bovis*. There were only a few in each Ox. Harms has seen the same worms in the œsophagus of Sheep; they were parallel to the longitudinal axis of the organ, and rolled up in a spiral manner like the wool-fibre of merino Sheep. Zürn found them to be identical with the *Gongylonema scutatum* of the Ox. Müller has also observed them in the epithelium of the œsophagus of an old Horse. Lastly, Korzil has seen them in the mouth and pharynx of Pigs, as will be mentioned immediately. Stiles has found them in abundance in American Cattle and Sheep.

Curtice says he has found in the walls of the œsophagus of the Ox, larvæ which he considers as those of the *Hypoderma bovis* in the first stage.

Strongylus Species ? (McFadyean).—This strongyle was found in 1896 by McFadyean in the fourth stomach of two Cows, and subsequently in other Cattle, which were slaughtered in consequence of emaciation and persistent diarrhœa. On post-mortem examination the internal organs were found to be healthy save the fourth stomach and the intestines. The main seat of the disease was the abomasum, the mucous membrane of which was inflamed. Microscopic examination of the stomach wall and contents discovered the presence of numerous small round worms, of which the following is a description:

'The females are in excess of the males. There is also the usual disparity between the two sexes, the males being considerably smaller than the females. To the naked eye the colour of the worms is a dull white. The length of the females varies, but the average adult may be set down at 9 mm. The diameter of the body measured a little in front of the vulva is from 0·08 to 0·09 mm., and from the region of the vulva the body gradually tapers to the anterior extremity, while from the vulva backwards to near the tail it is almost uniform in thickness. The tail is slightly curved and terminated by a sharp point. The mouth is terminal, unarmed, and surrounded by a narrow, blunt collar. The wall of the gullet is very thick in its posterior part, where it terminates in an intestine that runs straight through the body. The anus is distant about 0·14 mm. from the point of the tail. Two small spine-like papillæ with a backward direction are present on opposite sides of the body; about 0·3 mm. behind the anterior extremtity.

'The orifice of the vulva is covered by a flap-like appendage of the integument. The integument is crossed by fine transverse ridges, and it also shows on either side (upper or lower) of the body ten to fourteen equidistant longitudinal ridges. The uteri are directed backwards and forwards from the vagina, and contain a large number of eggs somewhat obliquely placed, the one behind the other. The eggs measure 0·07 mm. in length by 0·04 mm. in breadth. Those near the vagina show the morula state of division.

'The adult male worms are about 7 mm. long, and the body is thickest at its posterior end, and gradually tapers towards the head. The spicules are dark yellow in colour, and 0·2 mm. long. The bursa, which is difficult to spread, measures about 0·3 mm. across at its widest part. The accompanying figure shows its appearance when fully expanded. The posterior ribs spring from a median stem, and each divides into two very short, thin branches. At its attached end the median stem of the posterior ribs sometimes appears cleft longitudinally, and it is flanked on either side by a delicate outward curved rod. The remaining ribs are all comparatively stout, and the postero-external and the anterior are double on each side. The bursal membrane shows five striæ running at right angles to its free edge.'

FIG. 143.—Caudal extremity of male worm from the fourth stomach of a cow; *Strongylus Species?* magnified (McFadyean).

This worm resembles Ostertag's *S. convolutus*; the most notable differences are the barb-like hooks on the neck and longitudinal ridges on the integument of McFadyean's nematode.

Strongylus gracilis (McFadyean).—Colour dull white. The adult female measures from 3 to 4 mm. long, and 0·06 mm. broad in front of the vulva. From the vulva backwards the breadth is maintained to near the tail, which runs out into a sharp point, and is almost straight. In front of the vulva the body tapers gradually to the anterior extremity, which has no collar or expansion. The integument shows very fine transverse but no longitudinal ridges. No neck papillæ are present. The anus opens 0·07 mm. from the

tip of the tail. The vulva is distant 0·75 mm. from the posterior extremity, and it is unguarded. The uteri pass backwards and forwards from the vagina, and contain eggs of relatively large size. These are arranged lengthways, the one behind the other, and measure 0·07 mm. long by 0·04 mm. broad.

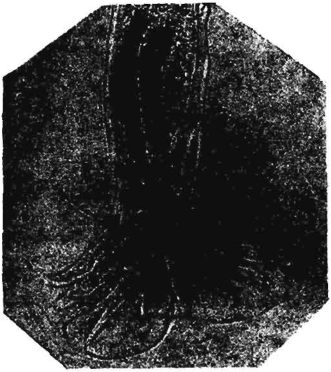

FIG. 144.—Bursa of male *Strongylus gracilis* (McFadyean).

The largest males are a little over 3 mm. long, and at their posterior extremity they are about 0·06 mm. broad. The body gradually tapers from the posterior extremity to the head. The spicules are 0·1 mm. long, and the bursa measures 0·125 to 0·18 mm. across at its widest part. The posterior ribs spring from a long (0·06 mm.) tapering median stem, and are themselves extremely short, as each almost immediately divides into two short branches. The median stem thus appears under a low magnification to divide into four prong-like branches at its free end. The postero-external rib is short, and the median is represented by two large branches separate down to their bases. The antero-external is of about the same size as the branches of the median, and the anterior is represented by two distinct ribs, the anterior of which is slender, and the posterior thick. Thus, omitting the posterior ribs, the bursa is supported on each side by six rays, of which the central four are nearly equal in thickness, while the outermost ones are shorter and more slender (McFadyean).

This strongyle was discovered in 1894 by McFadyean in cases of verminous gastro-enteritis of Cattle. Since then McFadyean has found the same species in the mucous membrane of the stomach of Sheep, Horses, and Pigs.

ARTICLE III.—Parasites of the Stomach of the Pig.

The parasites met with in the stomach of the Pig are NEMATODES.

1. **Spiroptera strongylina** (Rud.).—Body white, thin, and often curved in a semicircle. Head not distinct from the rest of the body. Mouth without lips and papillæ, and continued by a pharynx. A very narrow lateral wing on one side. *Male* 10 mm. to 13 mm. long; tail furnished with two broad, unequal wings; six papillæ on each side asymmetrically arranged, two of them being post-anal; spicules long and thin. *Female* 12 mm. to 20 mm., vulva situated immediately in front of the anus.

The *Spiroptera strongylina*—which appears to be rare—has been found in Germany in the cavity of the stomach. No trouble has been ascribed to it. It has been observed most frequently in the wild Boar.

2. **Gongylonema scutatum** (Müller).—This worm has been mentioned (p. 308) as being found in the Horse, Ox, and Sheep. Korzil has also often seen it in the

mouth and pharynx of the Pig, implanted in the epithelium, and more or less free on the surface of the mucous membrane. It does not seem to have produced any appreciable pathological effect.

3. **Gnathostomum hispidum** (Fedsch.).—'The anterior extremity is provided with twelve rows of chitinous plates, the summits of which are garnished with sharp hooks directed backwards. The *male* is 25 mm. long; its tail forms a kind of rounded pouch. The *female* measures 31 mm.; its body gradually tapers towards the end, where it terminates in a conical point' (Railliet).

This Nematode was found by the Russian traveller, Fedschenko, in the walls of the stomach of a Pig. Csokor has seen it in Vienna, where it is known to the pork-butchers as the *tricoloured worm*. It fixes itself in the mucous membrane by means of its hooks, and lives on the blood it extracts. The points it occupies are marked on the exterior of the stomach by distinct injection, involving the peritoneal serous membrane, and dark spots the size of a poppy-seed. Internally, the mucous membrane is inflamed, particularly at the fundus of the organ; while between the rugæ more especially, it is mammillated, reddened and thickened, and there the worms are observed to be implanted in it by their cephalic extremity. The stomach is more or less distended and disturbed in its functions, and there is often marked cachexia.

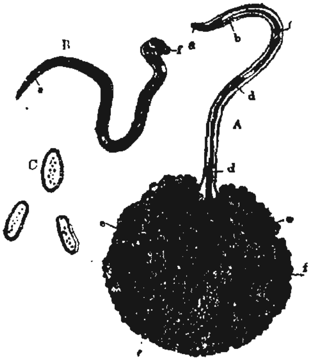

FIG. 145.—*Simondsia paradoxa*, after Cobbold.

A, female extracted from its cyst, magnified five diameters; *a*, cephalic extremity; *b b*, lateral wings; *c*, posterior end of the œsophagus; *d d*, intestine; *e e e*, cæca of the uterine rosette; *f*, tail. B, male, magnified five diameters; *a*, cephalic extremity; *f*, caudal extremity. C, group of ova extracted from the uterine cornua; magnified 250 diameters.

4. Cobbold has described, as the type of a new genus, a singular parasite, the *Simondsia paradoxa*. 'The genus **Simondsia** (Cobbold) is, in fact, represented by endo-parasitic Nematodes, the females of which have a very developed external uterus, from which spring several branches that end in a *cul-de-sac*. These females are encysted; the males are free.

'The **Simondsia paradoxa** (Cobbold) has a cylindroid body, attenuated towards the anterior extremity, which has two narrow lateral wings. The mouth has two prominent papillæ. The *male* measures 12 mm., it has a spiral tail, and two long, thin spicules. The *female* is 15 mm. long, and towards the posterior part of the body has a considerably-developed, rosette-shaped organ, formed by the everted uterus; the tail is twice as thick as the body, is conical, and has three spinules, with a long base, immediately above the anus. It is probable that the vulva opens at the base of the rosette.

'This remarkable parasite was discovered in 1852 by Simonds, in the walls of the stomach of a German Pig belonging to the Zoological Society of London. The males were free, and the females were enclosed in small tumours or cysts, from which they protruded their head by a narrow opening in the cavity of the stomach. In the first description Cobbold gave of this worm, he mistook its head for its tail' (Railliet).

ARTICLE IV.—**Parasites of the Œsophagus and Stomach of the Dog.**

Independently of the Infusoria, the parasite most frequently found in the stomach of the Dog is the *Spiroptera sanguinolenta*. We have also on two occasions seen the larvæ of the Gastrophilus of the Horse in it, and also wandering Ascarides from the intestine. *Tæniæ* may likewise find their way into the stomach, and Wolpert has even found them in the œsophagus.

Spiroptera sanguinolenta (Rud.).—This Nematode is readily recognised by its blood-red colour. The *male* is from 3 cm. to 5 cm. long, the tail spiral and provided with two lateral wings, each of these being sustained by six papillæ, of which two are post-anal; two unequal spicules. The female is 6 cm. to 8 cm. long; the tail is slightly curved, and the vulva is 4 mm. or 5 mm. behind the mouth.

This worm has been met with in the Wolf and Fox, and more particularly in the Dog. It is sometimes found in the aorta, lungs,

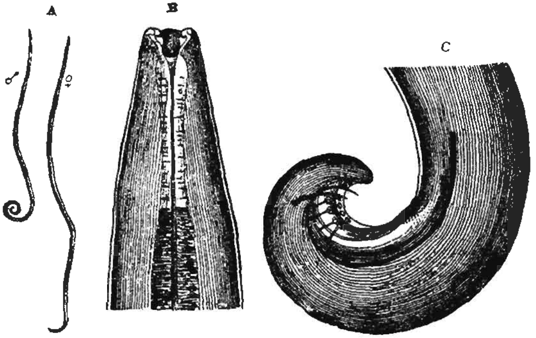

FIG. 146.—*Spiroptera sanguinolenta.*

A, male and female, natural size; B, cephalic extremity, showing the interior of the buccal capsule, magnified fifty diameters; C, caudal extremity of the male, lateral view; magnified twenty-five diameters.—Railliet.

and lymphatic glands; but it is lodged almost exclusively in tumours in the stomach and œsophagus. These tumours are never numerous; their volume varies in size from that of a hazel-nut to a pigeon's egg; their shape being ovoid and their consistence hard. The mucous membrane covering them offers no other alteration than a regular circular opening on their summit, but which may—in very exceptional instances—be absent. They are limited, outwardly, by the muscular coat of the œsophagus and stomach, and are composed of indurated tissue chambered into cavities, in

which the rolled-up worms are imbedded in a purulent fluid that under pressure issues from the opening, and also follows extrusion of the parasites. This orifice is in communication with all the cavities in the tumour. The number of worms in each tumour is very variable, generally from 2 to 20.

Silva Aranjo has found five *Spiroptera sanguinolenta* free in the œsophageal cavity of a Dog.

Morgagni and Ercolani have imagined that these parasites—being introduced into the stomach in the larval condition—perforate the mucous membrane and develop in the submucous connective tissue. Davaine is of the contrary opinion, and thinks that—owing to their tenuity in the first stage—they find their way into the duct of an œsophageal or gastric gland, causing its dilatation and inflammation, and ultimate conversion into a verminous tumour. He bases his opinion on the form of the opening, which does not appear to be eroded or ulcerated. In the larger proportion of cases, the duct of the gland remains permeable; but in others it becomes obliterated, perhaps by the compression of the tumour itself upon it, even when it is permeable; so that there goes on a transformation analogous to that so frequently observed in the sebaceous follicles, in the glands of the lips, etc. But the histological study of these tumours can alone solve this undecided question.

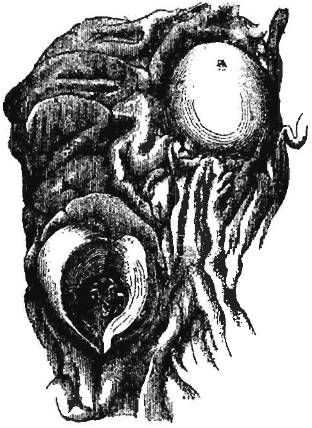

FIG. 147.—Tumours of the *Spiroptera sanguinolenta* in the stomach of the Dog; natural size.—Railliet.

One of these tumours has been incised to show the internal cavity and the worms contained therein.

The *Spiroptera sanguinolenta*—which is common in China and Brazil—appears to be more frequent in Italy than in France, where it is somewhat exceptional. We need only refer to its most characteristic symptoms. According to Manson, its presence in the œsophagus is manifested by repeated vomitings, which may terminate in death from inanition; the tumours may open into the peritoneum, and—as a consequence of their rupture—occasion

a fatal pleurisy. Littlewood has also remarked frequent vomiting in a Dog, the stomach of which contained numerous nests of Spiroptera. The Spiroptera of the stomach has been sometimes considered as the cause of a voracious appetite with which several of the animals attacked appeared to be affected. A relatively large proportion of the observations with regard to this parasite have been of Dogs dead from rabies ; but this may be explained by the circumstance that the autopsy of rabid Dogs demands a careful examination of their stomach. And it may also be the case that this Nematode at times induces rabiform symptoms, which have led to mistakes, and caused Dogs exhibiting them to be sacrificed as rabid.

Recent investigations by Grassi have made known the evolutive cycle of the *Spiroptera sanguinolenta*. This worm has for its intermediate host the Eastern Cockroach (*Periplaneta orientalis* Linn.), one of the insects commonly known in France as *Cafard* and *Cancrelat* (American Cockroach). In the abdominal cavity of this creature, Grassi, at Catania, has often found relatively large cysts containing young Nematodes, the colour of which resembled that of the Spiroptera in question ; and Dogs to which he had administered a large quantity of these cysts have—at their autopsies —shown young parasites which, at the end of fifteen days, had already embedded themselves in the œsophageal mucous membrane. It is probable that this Cockroach finds its parasite in the excrements of Dogs which are bearers of the Spiroptera, and that the Dogs in their turn are infested in eating these Insects ; for Grassi affirms that many Dogs like chasing Cockroaches.

Seeing the relative rarity of the helminthiasis caused by the Spiroptera, and the absence of precise symptoms indicative of its existence, nothing can be said with regard to the treatment of the affection.

Larvæ of the Œstridæ.—Larvæ of the *Gastrophilus equi* have been found in the stomach of carnivorous animals, such as the striped Hyæna and the Badger. G. Colin has met with one once in a four or five months' old Newfoundland Dog, 'pupped at the beginning of winter, and on which no *Œstrus* could have deposited its eggs. But as it had been fed upon the débris of Horses, a larva, no doubt, had been swallowed with that food, and had been arrested in the stomach, where it had hooked itself on to the mucous membrane, in which it had made a depression to lodge the posterior extremity (*sic*) of its body.' Schliepe, at the autopsy of a rabid Dog, found in the cardiac diverticulum of the stomach 'three larvæ of the *Œstrus equi* firmly implanted in the mucous membrane, and as well developed as those found at this time, December, in the stomach of the Horse.'

ARTICLE V.—**Parasites of the Stomach of the Cat.**

Ascarides and Tæniæ may be found in the stomach of the Cat, and particularly the *Tænia crassicollis* ; but the only parasite proper to that organ is a Nematode of the family of Strongylidæ—the **three-pointed Ollulan** (*Ollulanus tricuspis* Leuckart). To Leuckart we owe its discovery and description.

The genus *Ollulanus* is characterized by the presence of an urn-shaped buccal capsule, a slightly muscular œsophagus, and—with the *males*—a caudal bilobate pouch, containing two short spicules. In the *Ollulanus tricuspis*, the adult *female* measures at most 1 mm. long, and has three points at the caudal extremity.

In the adult state, the worm resides in the substance of the gastric mucous membrane of the Cat, where it is often found in such quantity that this membrane is softened, reddened, and ecchymosed. The female is ovoviviparous. The embryos are of colossal dimensions, compared with those of the parent—measuring, in fact, 320 μ long, and 15 μ broad; the body of the female can scarcely contain more than three of them. Nevertheless, they are found in large numbers not only in the stomach, but also in the intestine as far as the large colon, whence they soon wander—like the Trichinæ—to various parts of the body of their host—invading more particularly the pleuræ, diaphragm, liver and lungs, where they form cysts measuring ·15 mm. to ·20 mm., in each of which are found one or several embryos rolled up on themselves. The wall of the cysts is very thick, and the cavity relatively restricted. In the lung they simulate miliary tubercles, each being surrounded by a zone of hepatization; and the inflammatory process may be so extensive as to cause the death of the animal. In serious cases, the embryos are met with in the more or less sanguinolent bronchial mucus.

The embryos of the *Ollulanus tricuspis* cannot continue their course of development in the Cat. The majority of them are expelled along with the fæces, or, exceptionally, with the bronchial mucus. They may then be ingested by the smaller Rodents, and—as Leuckart has experimentally demonstrated—they pass from the intestine of these into the muscles, where they become encysted, after the manner of the Trichinæ. There development becomes more advanced than it can be in the pulmonary or other cysts in the Cat; but it is probable that it is completed in the digestive canal of the Cat that feeds upon infested Rodents. Nevertheless, Leuckart, having fed a Cat with mice experimentally infested, on killing it eight days afterwards, found the worms—not in the stomach, but in the cæcum and large intestine, and they had undergone no change. So that uncertainty still prevails with respect to the evolution of the Ollulan. We think it should be mentioned that in our numerous autopsies of Cats, we have never met with this parasite.

Lutz says that, in Brazil, he saw in the stomach of a Cat a great number of worms—male and female—which he believed belonged to the genus *Physaloptera*, of which we shall speak hereafter when dealing with the Brazilian species found in the stomach of the Fowl. These parasites are very closely related to the *Ph. digitata* Schneider, that lives in the stomach of the Cougar or Puma (*Felis concolor*).

It is possible that these worms were only Physalopteres of the Fowl, and had been ingested with the entrails of that Bird. We have found in the intestines of a Cat, intact *Heterakis papillosa*, which had evidently been derived from this source.

ARTICLE VI.—**Parasites of the Stomach of the Rabbit.**

The **Striped Strongyle** (*Strongylus strigosus* Dujardin) chiefly infests warren Rabbits, being found in the cæcum and colon. Railliet has found it in thousands in the stomach of these animals, in which it gives rise to a fatal anæmia, by abstracting blood from the gastric mucous membrane. The same worm has been found by Railliet, in small numbers, in the stomach of domesticated Rabbits at Alfort; and Perroncito has made a similar observation at Turin. But up to the present time, a real pathogenic action in domesticated Rabbits has not been attributed to this Strongyle.

It is recognised by the following characters:

Body blood-red, filiform, cuticle striated transversely, and having about 50 salient longitudinal lines. *Male*, 8 mm. to 16 mm. in length, and provided with two long spicules with a brush-like termination; a campaniliform caudal

pouch, deeply excised in front, slightly bilobate behind, its posterior ribs fused into one for the greater portion of their length, and divided into two branches at their posterior extremity; the posterior and anterior external are single; the middle and anterior are double. *Female*, 11 mm. to 20 mm. long; vulva distant from the caudal extremity 2·14 mm. to 3·28 mm.

Moniez has found beneath the gastric mucous membrane of the Rabbit and Hare, a particular Spiroptera which he has named the *Spiroptera leporum*.

FIG. 148.—*Strongylus strigosus*: caudal extremity of the male, seen on the ventral surface; magnified forty diameters.—Railliet (inedited).

ARTICLE VII.—**Parasites of the Œsophagus and Stomach of Birds.**

The Fowl, Goose, Duck, and Swan are the only ones that harbour Helminthes in the pre-intestinal portion of that canal. With the exception of one species of Trematode found in the Fowl, these are all Nematodes belonging to six different genera. Three—*Strongylus* Müller, *Hystrichis* Duj., and *Physaloptera* Rud.—belong to the family of Strongylidæ; one—*Trichosomum* Rud.—belongs to the Trichotrachelidæ; and the two others—*Dispharagus* Duj. and *Tropisurus* Dies.—belong to the Filariidæ.

FOWL.—In the œsophagus of a Fowl, Von Linstow found five specimens of a Trematode, which he named *Distomum pellucidum*, and which—because of the situation, altogether in front, of the genital openings—should be included in the genus *Mesogonimus*—*Mes. pellucidus*. It is transparent, reddish, foliaceous, attenuated in front, has two large and equal-sized suckers, is covered with spines on its posterior moiety, and measures 9 mm. long, 5 mm. broad.

Zurn indicates as having been found by Mollin, beneath the œsophageal epithelium of the fowl, the *Trichosomum annulatum*, which will be described with the parasites of the intestine.

Another parasite of the œsophagus is the **Dispharagus spiralis** (*Molin*)—a name given to the genus by Dujardin, because its œsophagus is formed of two distinct portions, and, besides, succeeds a cylindrical ventriculus. The spiral Dispharagus has three papillæ around the mouth; and the anterior part of the body has a flexuous cord on each side. The *male* has a spiral tail with wings, a single spicule, and is 7 mm. long. The *female* is 9 mm. long.

They are probably embryos of this species that Rivolta and Delprato described under the name of *Trichina papillosa*. They found them in the Fowl, encysted in the connective tissue around the œsophagus, crop, and proventriculus, as well as in the wall of the intestine, and in the mesentery

near its visceral insertion. To the same species may also belong the worms previously found in nodules in the wall of the Fowl's gizzard, which were considered as belonging to the genus *Spiroptera*.

Another species of Dispharagus—*D. nasutus* Rud., *Filaria nasuta* Rud.—has been found in the wall of the gizzard of the Fowl and Sparrow. The *male* was closely rolled up in a spiral manner, and measured 5 mm. long; the *female* was from 5 mm. to 7 mm. long. It received the name of *nasutus*, from the two long terminal papillæ on each side of the mouth, from which start two double, flexuous folds of integument that pass to a distance of ·6 mm., then curve forward without joining.

Legros has reported an epizoöty due to this species, among the poultry in a yard where several breeds of Fowls were kept, and of which the Crèvecœur breed suffered most severely. The Birds became emaciated, were dejected, and died exhausted without having lost their appetite; on the contrary, during their last few days they were unusually voracious. The gizzard was studded with the *Dispharagus nasutus*—some being entirely hidden in the substance of the mucous membrane, and others fixed in it by one extremity, the other floating freely in the cavity of the organ. They were packed so close together in certain places, that they appeared to form a kind of tissue.

The *Dispharagus hamulosus* Dies. was discovered by Natterer in small tumours on the surface of the gizzard of a Brazilian Fowl. The *male* is 10 mm. to 12 mm. long; the *female*, 24 mm. to 26 mm.

The genus **Physaloptera** is characterized by its mouth, which has two greatly developed lips, each provided with three papillæ externally, and having teeth internally and at the extremity. The caudal pouch of the male is closed, and embraces the base of the tail. The female is oviparous. The **truncated Physaloptera** (*Phys. truncata* Schn.) measures: *male*, 25 mm., and *female* 33 mm. long. It has also been found in Brazil, in the proventriculus of the Fowl.

Bakody believed he had found Trichinæ encysted in the walls of the ventriculus and intestine of Fowls which had succumbed to a small outbreak of disease. But, as Leuckart has observed, they were evidently not Trichinæ, but the larvæ of some Filariæ capable of encystment, which is not rare in various animals.

DUCK.—Railliet and Lucet have attributed to a Nematode—the *Trichosomum contortum*—a most serious disease affecting a lot of young Ducks of Pekin breed.

The **Trichosomes** (*Trichosomum* Rud.) belong to the family of Trichotrachelidæ. The body is filiform, very attenuated in its anterior part, *moderately and progressively expanded in its posterior part*. The *male* has the caudal extremity rolled up, and terminated by a small caudal copulatory pouch that forms around the genital orifice a kind of ring; the sheath of the spicule is transversely striated or ridged. This genus has its chief representatives in Birds.

The **Trichosomum contortum** (Creplin) is slightly attenuated near the posterior extremity. The anterior has a terminal projection like a button. The *male* is 12 mm. to 17 mm. long, and 7 μ to 9 μ broad near the head, and 75 μ to 80 μ in the posterior region; it has a very slender spicule, the sheath of which is covered with very small spines directed forwards. The *female* is 31 mm. to 38 mm. long, and 9 μ or 10 μ broad at the head, 120 μ to 150 μ posteriorly; it has the vulva opening about the anterior sixth of the body. Ova from 48 μ to 56 μ long, and 21 μ to 24 μ broad.

This Nematode has been found in various species of Passeres, Grallatores, Palmipedes, and Raptores. According to the observations of Railliet and Lucet, it causes in Pekin Ducks an engorgement—by food—of the cervical dilatation of the œsophagus, altogether analogous to dilatation of the crop in the Gallinæ and

Pigeons. This *ingluvial indigestion*—so named by Dupont of Plazac—has been attributed to various causes—such as the food being too dry, too abundant, swallowed too hurriedly, or undigested. But the above authorities have shown that perhaps the chief factor is parasitism by the *Trichosomum contortum;* for at the autopsy of Birds that have died from this affection, they have only found alterations in the œsophagus, which was enormously distended in its cervical portion, and full of food; while its walls were extremely thin and very congested. To the naked eye, or through a hand-lens, the mucous membrane at that part shows white or light-yellow lines, sometimes slightly in relief. The microscope proves that these streaks are submucous galleries partly occupied by the parasites and their ova, and have been formed by them in their movements and turnings around the œsophageal glands. One œsophagus may contain more than thirty worms.

These Nematodes act, no doubt, mechanically in causing obstruction of the œsophagus; this first leads to inertia, then to its engorgement and extreme dilatation, with compression of the pneumogastric nerve, whence result the phenomena of asphyxia.

The symptoms of this affection consist at first in an arrest of growth, and emaciation and weakness, with sometimes epileptiform crises. In about five to ten days engorgement of the œsophagus commences, and it rapidly increases until death ensues in one or two days.

The conditions prevailing at the appearance of this affection are not known. It is only recognised that youth and breed predispose to it; for ordinary young Ducks reared in the same conditions as those of the Pekin breed, pay but an insignificant tribute to this ingluvial indigestion. From what is known of the evolution of the Trichocephalus and hepatic Trichosomum of the Muridæ (Railliet), it is probable that the *Trichosomum contortum* has a direct development. Otherwise, its sub-mucous sojourn—notwithstanding its frequency—is, doubtless, only accidental; for in the other Birds in which it has been observed, it is nearly always found free in the œsophagus.

With regard to treatment, all that can be advised is the employment of anthelmintics best suited for destroying entozoa in the intestinal canal.

The **hooked Dispharagus** (*D. uncinatus* Rud.) is another parasite of the Duck's œsophagus, where it has been found by Zürn. The mouth is furnished with six papillæ and two teeth; from each of the latter arises a flexuous cord that descends to 2 mm. from the anterior extremity. On each side of the body is a double longitudinal series of small spines, with their points inclining backwards—a series that extends nearly to the caudal extremity. In front, the two series are on the dorsal surface, between the two cords, and approach the mouth. The *male* is 9 mm. long, has eight papillæ on each side—four of which are post-anal—a salient caudal pouch on each side, and a long and thin spicule. The *female* measures 15 mm.; the vulva is 1 mm. from the caudal point. Zürn has met with these worms in large numbers in the œsophagus, the crop, and the small intestine of Ducks that had died somewhat suddenly. They had produced severe inflammation of these parts. The precursory

symptoms of death had nothing characteristic—dulness, upright feathers, *dysphagia*, and a *great appetite being nearly all the signs that were observed.*

The genus **Tropisurus** (Dies.) is represented by two species in the domesticated Duck. It is remarkable for sexual dimorphism. The *female* has a thick ovoid body; the *male* is filiform, and 15 to 18 times longer than it is broad, with its tail careened downwards (τρόπις, keel). The species found in the tame Duck are the *Tropisurus inflatus* Mehlis, and the *Tr. fissispinus* Dies. They inhabit sub-mucous cysts in the proventriculus and the œsophagus, and sometimes set up fatal inflammation of these parts (Zürn).

The genus **Hystrichis** (Duj.) is composed of filiform worms, the anterior portion of their body being studded with prickles. They are lodged between the mucous and the muscular coats of the digestive canal of Birds. Two species are sometimes found in the tame Duck: 1. *Hystrichis tricolor* Duj.—so named because the female, which is 27 mm. long, is white externally, black in the centre or intestine, and bright-red in the intermediate layer and the whole of the œsophageal region. It has been found in the proventriculus of the tame Duck, and so firmly implanted in the mucous membrane that it has been found very difficult to remove it therefrom without breaking it. 2. *H. elegans* (Olfers), found at Geneva by Jurine, in nodules from the œsophagus of the tame Duck. Body white, thick, filiform, and 9 cm. long.

GOOSE.—The *Dispharagus uncinatus*, which Zürn found in the Duck, has been met with several times in the domesticated Goose, in nodules in the œsophageal mucous membrane.

The **Strongylus nodularis** (Rud.) is sometimes found in the tame Goose, in the substance of the mucous and muscular coats of the proventriculus and duodenum. It is tapering in front: the mouth has, laterally, two vesiculous wings in the form of nodules, and at the posterior part the pharyngeal bulb carries three teeth which can be projected externally. The *male* is 10 mm. to 12 mm. long, and has a well-developed caudal pouch with radiating sides. The *female* is 10 mm. to 18 mm. long, and has the vulva situated 1·5 mm. from the caudal point.

SWAN.—In the succentric ventricle of the *Cygnus olor*—domesticated or wild—there has been found on several occasions a species of Hystrichis—the *H. cygni* Molin—implanted in nodules in the mucous membrane.

CHAPTER III

PARASITES OF THE INTESTINE

Of the several portions of the digestive canal, the intestine is that in which nearly the greatest number of parasites are found. Their rapid passage in the mouth, pharynx, and œsophagus scarcely allows them time to fix themselves there; besides, they do not find there the abundant liquid medium the intestine affords, and they would be continually disturbed by the energetic contractions of these organs. The stomach is scarcely more favourable for their lodgment, as the acidity of the gastric juice drives them out of it, those which remain being generally refugees beneath the mucous membrane. By its alimentary contents, its extent, and the slowness and smoothness of its movements, the intestine is the place most suitable for the development and sojourn of the numerous parasites, the germs of which are carried therein by the food and water. The majority of these parasites infest the small intestine, others the cæcum, the minority the colon; and each species has generally its particular sojourn, and its exclusive location in the same compartment.

With the exception of some inferior Fungi, the parasites of the intestine belong to the animal kingdom. They are the Coccidia, Infusoria, Cestoda, Trematoda, Acanthocephala, and Nematoda.

CESTODES.—The *Cestoda*, or *Tape-worms*, are Platyhelminthes, the body of which is in the form of a narrow band divided into more or less distinct segments. One of the extremities—termed the *head*, and generally expanded—has a fixation apparatus formed of suckers, and also frequently of hooks. The head is often succeeded by a thin, non-annulated constriction, named the *neck*. The mass of the body is constituted by a connective network of cells, with anastomosing prolongations. From these cells all the organs are derived; they may be covered with carbonate of lime, and form calcareous concretions, which are frequently present in the body of these worms. The integument comprises—from without to within—an apparently homogeneous *cuticle*, lying on a *sub-cuticular layer* formed of large contractile cells, beneath which is found the *muscular* layer; this layer is double, the superficial portion being composed of longitudinal, and the deep of transverse, fibres.

The nervous system consists of two longitudinal cords united by a transverse commissure at the head. There is no digestive apparatus, the nutritive materials in the intestinal canal of the host of the Cestode passing into its body by fine canaliculi that traverse the cuticle. There is neither circulatory nor respiratory apparatus—the integument serving for the exchange of gases.

The excretory apparatus is represented by what are termed *aquiferous vessels*—longitudinal canals, generally four in number, two on each side—a dorsal and a ventral—which intercommunicate by transversal anastomoses. They open on the posterior surface of the body by an orifice—the *caudal foramen*—which is formed in the last segment, after shedding of the one behind it.

Each segment is hermaphrodite; but the male organs appear before the female ones—the younger rings or segments, situated near the head, being at first exclusively masculine. The *male apparatus* is formed of numerous testicular, pyriform vesicles situated at the extremity of the deferent canals, which open into a common excretory canal — the *spermiduct*. The sinuous extremity of the latter ends in a muscular pouch—the *cirrus-pouch*, that opens at the summit of a more or less salient mamelon, situated on the lateral border or the ventral surface of the segment, and is named the *genital pore*. The extremity of the spermiduct may, on becoming everted, protrude beyond the sexual orifice to constitute a copulatory organ—the cirrus or penis.

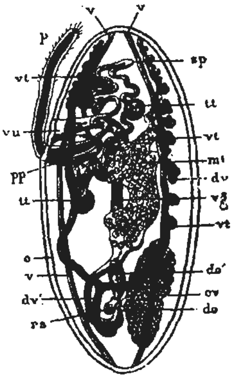

Fig. 149.—Diagram of the structure of a Cestode segment.—After Van Beneden.

tt, testicles; *sp*, vas deferens or spermiduct; *pp*, sac of the cirrus or penial pouch; *p*, cirrus or penis; *ov*, germigen or ovary; *do*, germiduct or oviduct; *vt*, vitellogen; *dv*, vitelloduct; *mt*, uterus, showing the mode of formation of the lateral cæca; *rs*, seminal reservoirs; *vg*, vagina; *vu*, vulva; *v*, excretory vessels; *c*, integumentary envelope.

The *female apparatus* comprises one or more ovaries. The ova—gathered together in a pavilion—pass into the oviduct, and thence into the uterus, which is an irregular tube that becomes distended by the accumulation of ova, and develops into numerous lateral cæcal pouches in gradually effacing the other organs; sometimes the distended walls rupture, and the ova are then dispersed in the central zone. The integuments of the segment may even give way under the internal pressure, and the ova escape externally. In Bothriocephalus, the uterus has a natural opening on the external surface. The vulva—situated near the male orifice—is continued by a vagina that terminates in the oviduct, near its origin, to convey the spermatozoa that the cirrus throws into it. In one part of its course, the vagina has often a dilatation that serves to retain the semen; this is the *seminal receptacle*. There is also, besides, a *vitellogen (yolk-gland)*—a mass of glands that secrete the vitellus, which is conveyed into the oviduct by a *vitelloduct*.

When the ova are laid, they usually contain an embryo provided with hooks, generally six in number. This embryo does not become an adult Cestode until after a series of migrations. It exists in a larval, agamous form, in the tissues of a transitory host; then, with it, it passes into the intestine of a second animal, in which it fixes itself and acquires—along with the sexual organs—its adult form.

Of the small number of families in the Cestodes, only two furnish parasites to Mammalia and Birds. These are the *Tæniadæ* and *Bothriocephalidæ*.

1. *Tæniadæ*.—This family is almost reduced to the genus *Tænia* Linn., which comprises more than four hundred species.

The Tæniæ—typical of the Tapeworms—are characterized by their head, which is always furnished with four suckers—the structure of which is analogous to that of the suckers of the Trematoda (p. 273)—between which is sometimes found a more or less marked depression, at other times a prominence named the *proboscis* or *rostellum*, which may or may not be contractile, nude, or armed with hooks. Besides, the segments or joints have nearly always their genital openings on their margin.

The phases of development are known for only a small number of species, which undergo a series of complex metamorphoses. At its exit from the ovum into a suitable medium, the embryo—always provided with six hooks (*hexacanthus*)—receives the name of *protoscolex* or *proscolex*. It is the first larval form, which penetrates the organism of a primary host—a vertebrate or invertebrate—there it looses its hooks, often becomes enveloped in a cyst produced in the body of the host, and is transformed into a vesicle—*caudal vesicle* (or *bladder*)—which has fluid contents and a contractile wall (cystic form, *finn* or bladder parasite). This Cystic or bladder worm develops by budding, at one or more points, a second larval form—*deutoscolex*, or simply *scolex*—which has the same conformation as the anterior extremity of the Tænia, except that the head is invaginated.

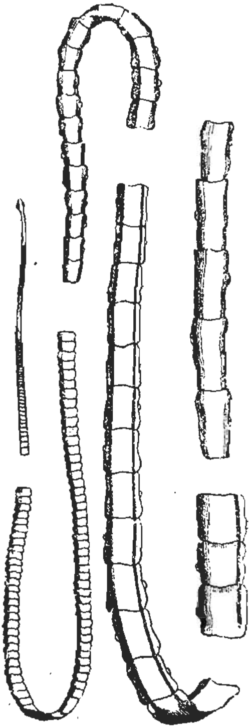

FIG. 150.—*Tænia solium*; natural size.—Railliet.

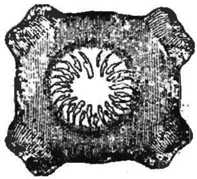

FIG. 151.—Head of the *Tænia solium*, seen in front, with its salient suckers. —Leuckart.

The tissues which contain it being introduced into the digestive canal of a suitable host—a Vertebrate—the scolex separates from the vesicle, the head is evaginated and becomes fixed on the intestinal mucous membrane, and by

proliferation produces a linear series of rings (segments or joints)—thus constituting a Tape-worm. In the adopted nomenclature, the chain takes the name of *strobila*, and each sexually mature segment that of *proglottis*.

The numerous species of Tæniæ are distinguished from one another by their dimensions, the form of their segments, the arrangement of the genital organs, and the presence or absence of the cephalic armature. The number, size, shape, and arrangement of the hooks are very important characters, but they are, nevertheless, liable to limited variation in each species. A useful distinction, from a practical point of view, is that of dividing the Tæniæ into armed and unarmed—according as the head has hooks or no hooks; though this distinction is not really scientific, and does not take into account the true affinities indicated by the mode of development, on which alone the classification should rest. Unfortunately, only a very small number of species are so identified, and the classification of these has been established principally by the researches of Abilgaard, Von Siebold, Van Beneden, Küchenmeister, Haubner, Baillet, Redon, Moniez, Villot, etc.

We shall have occasion to refer to several in detail, in dealing with some of those which are parasitic in the domesticated Mammalia. For the present, we will give a summary description of the classification of the Tæniæ of the domesticated animals, such as has been made by Railliet, according to the memoirs of Villot.

The Tæniæ referred to are divided into three groups: *Cystotæniæ*, *Cystoïdotæniæ*, and *Anoplocephalinæ*.

A. **Cystotænians** (*Cystotæniæ*).—'They are characterized by Cystic larvæ, which have the caudal vesicle proceeding from the proscolex by simple increase and modification of structure, without the production—properly speaking—of a new part' (Villot).

The head is nearly always armed with hooks like small daggers, arranged in a double crown, and the genital pores of the strobila—single in each segment—are irregularly alternate. The *Cystotæniæ* form three secondary groups, *Cysticercus*, *Cœnurus*, and *Echinococcus*, which are found in the tissues or closed cavities of the Herbivora, Omnivora, and exceptionally in the Carnivora; while the strobilæ live in the digestive canal of the latter. The larva, *finn* or bladder-worm is always enveloped in a cystic membrane, furnished by the organism of the host.

FIG. 152.—Diagrammatic section of the Cysticercus.

The *Cysticerci* (*Cysticercus* Zed.) are monosomatic and monocephalic—that is, their caudal vesicle gives rise to a single body having only one head.

The *Cœnuri* (*Cœnurus* Rud.) are polysomatic and monocephalic, their caudal vesicle giving origin to multiple bodies, each of which only possesses a single head (Fig. 153).

The *Echinococci* (*Echinococcus* Rud.) are polysomatic and polycephalic; their highly cuticularized caudal vesicle produces numerous bodies (*proligerous vesicles*), each of which bears several heads.

These diverse Cystic forms will be specially studied with regard to the organs in which they are found. The strobilæ derived from them are the cause of intestinal helminthiasis in the domesticated Carnivora.

B. **Cystoïdotænians.**—In the *Cystoïdotæniæ* 'the caudal vesicle is formed by budding of the proscolex—that is, by the addition of a new part.' (Villot).

The Cystic larvæ of Tæniæ of this group have—like those of the preceding group—a caudal vesicle, a body, and a head; but they also have a fourth part which Villot named the *blastogene*. The head, in itself, represents the future scolex. The body and caudal vesicle are the parts proper to the Cyst. With regard to the blastogene, it represents the proscolex, which here preserves its autonomy and all its embryonic characteristics. The caudal vesicle is very small, and contains no fluid; hence the name of *Cysticercoïds* given by Leuckart to this group of Cystic larvæ. They are all parasites of Invertebrata, and are lodged in the tissues or cavities in the body of their host; they are not surrounded by a cystic membrane, like the preceding group.

Villot divides this group into two sections, according as the formation of the caudal vesicle takes place by endogenous or exogenous budding. The second section alone contains a cystic form related to the parasitic Tæniæ of Mammalia. This is the subgenus *Cryptocystis* (Villot), which differs from the other Cysticercoïds by its relative simplicity of organization, by its separation from

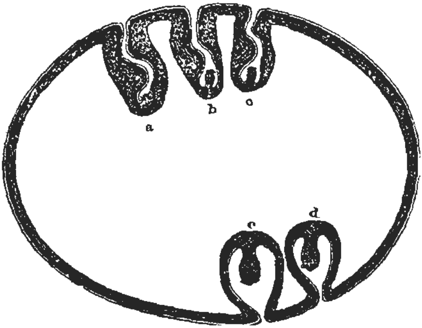

FIG. 153.—Diagrammatic section of the Cœnurus.—Railliet.

a, scolex in its normal arrangement; *b*, *c*, *d*, *e*, increasingly diagrammatic, in order to show the conformity of the Cœnuri and Cysticerci.

the blastogene at maturity, and by the fact that it is not proliferous. The only representative of this subgenus is the cystic form of an armed Tænia of the Dog, *Dipylidium caninum* or *T. cucumerina*.

C. **Anoplocephalinæ.**—The Anoplocephalinæ (*Anoplotæniæ*) are *true unarmed* Tæniæ, the evolution of which is absolutely unknown; their head has neither rostellum nor hooks, the segments are much wider than they are long, and the embryos are surrounded by a pyriform apparatus (Railliet).

All the Tæniæ of this very artificial group belong to the Herbivora, and their history—still very incomplete—scarcely embraces more than generalities. The majority are species of *Dipylidium*, or tæniæ, which have two genital pores on each border of each segment. The pyriform apparatus surrounding the embryo—which is given as a characteristic of the group—has not been seen in all the forms enumerated. Nothing is known as to their migrations.

Lastly, an unarmed Tænia is found in the Dog—*T. litterata*—which, in all its characters, is absolutely outside the preceding groups, and remains isolated in a crowd of numerous species of Tæniæ.

With regard to the Tæniæ of Birds, their diversity, and the absence of information as to their migrations, permits their being assigned to a distinct group to which the preceding taxonomic considerations do not apply.

2. BOTHRIOCEPHALIDÆ.—This family has for its type the genus **Bothriocephalus** (Brems). They are Tape-worms, the head of which is destitute of hooks, and provided with only two suckers in the form of elongated fossæ. The genital orifices are situated on the ventral surface of the segments. The majority of the numerous species of Bothriocephalus live in fishes, though some are found in the Carnivora and domesticated Birds, as well as in Man.

ACANTHOCEPHALA.—The Acanthocephales (*Echinorhynchus* O. F. Müller) have a proboscis armed with curved hooks, by which they fix themselves to the intestinal wall of their host. This proboscis may be doubled up in a special sheath, fixed—by its posterior extremity—to the side of the body by a ligament and retractor muscles. The nervous system consists of a ganglion, at the bottom of the sheath, which sends off some filaments. There are no sensory organs; neither is there a digestive apparatus, the absorption of nutrient fluids being effected by endosmosis through the integuments.

FIG. 154.

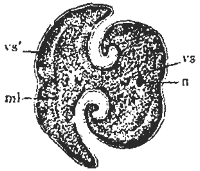

FIG. 155.

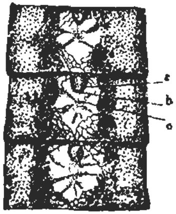

FIG. 156.

FIGS. 154 to 156.—*Bothriocephalus latus*.

Fig. 154, head, showing the two longitudinal fossæ or suckers; Fig. 155, vertical section through the middle of the head, after Moniez: *n*, nerve cords; *vs*, vessels of the central zone; *vs'*, sub-cuticular vessels; *ml*, longitudinal muscular fibres. Fig. 156, three ripe segments, magnified and seen on the ventral surface, after Eschricht: *a*, male orifice, opening of the vagina; *c*, orifice of the uterus, from which the eggs are deposited. The cirrus is salient at the third segment; it is retracted in the other segments.

The sexes are separate. The *males* have two ovoid testicles, the excretory canals of which unite in a common vas deferens, which is often furnished with accessory glandular sacs. At the posterior extremity of the body, this common canal opens into a conical penis situated at the bottom of a campanuliform pouch, which can become everted and serve as a copulatory organ. The *female* organs comprise an ovary, the produce of which falls into the visceral cavity; the ova are collected in a belt-shaped uterus, continued by a short vagina that opens at the posterior end of the body. The embryos developed in these ova have to undergo somewhat complex metamorphoses and migrations, before reaching their adult state. In the larval condition, the species inhabit the visceral cavity of various Crustacea or Insects, where they become encysted. The sexual and adult condition is only realized when this primary host is introduced into the digestive tube of a Vertebrate—Fish, Bird, or Mammal.

NEMATODES.—The intestinal Nematodes belong to the following families and genera :

1. Ascaridæ : genera *Ascaris* and *Heterakis* ;
2. Oxyuridæ : genus *Oxyuris* ;
3. Strongylidæ : genera *Strongylus*, *Œsophagostomum*, *Globocephalus*, *Sclerostomum*, *Anchylostomum*, and *Ollulanus* ;
4. Trichotrachelidæ : genera *Trichocephalus*, *Trichosomum*, *Trichina* (*Trichinella*) ;
5. Filariidæ : genera *Filaria* and *Spiroptera* ;
6. Angiostomidæ : genus *Strongyloides*.

These various genera, besides the characteristics of families or tribes, are also recognised as follows :

Ascaris (Linn.).—The borders of the lips are generally denticulated. The *males* have two equal spicules, and about the anus numerous papillæ, which —according to Schneider—constitute one of the best specific characters. The ova are globular or ellipsoïd.

This genus contains numerous species, commonly—but wrongly—named *lumbrici*, which inhabit the small intestine. Almost every species of the domesticated Mammalia has a corresponding species of Ascaris, subordinate — with regard to dimensions—to the size of the host. The vitellus does not become segmented in the intestinal canal of the host in which the eggs are deposited, but after their expulsion from its body, if they find the necessary conditions of warmth and moisture. However, if their development does not occur in a moist situation, the ova of the Ascarides—according to the observations of Leuckart—may resist complete desiccation for weeks, or even months, and also alternations of damp and drought. The embryo, when once formed, is set at liberty in the intestine of another host of the same species as the first, on its shell being dissolved by the digestive fluids (Davaine, Baillet). It may, nevertheless, be hatched externally on grass or damp soil, but not in water (P. Hallez).

A B

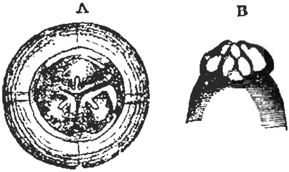

FIG. 157.—Anterior extremity of *Ascaris lumbricoides* of Man.
A, front view ; B, dorsal view.

Leuckart and Von Linstow had supposed that the passage of the ova of the Ascarides through an intermediate host—an Invertebrate—was necessary ; but the experiments of Grassi demonstrate that the embryos may directly undergo their ulterior development in the definitive host ; and Laboulbène confirms these observations.

Heterakis (Duj.).—This genus is distinguished from the preceding by the presence, in the *male*, of a pre-anal sucker and of two unequal spicules, as well as by at least three pre-anal papillæ on each side, larger than the others.

Among the domesticated animals, Poultry alone harbour species of Heterakis.

Oxyuris (Rud.).—This offers the characters of the family (see p. 279).

Strongylus (Müller—see p. 279). The more interesting species of this genus infest the air-passages. Some are found in the intestines of Ruminants and the Rabbit. All have, probably, a direct development.

Œsophagostomum (Mol.).—*The mouth is not succeeded by a buccal cavity or capsule, but opens directly into the œsophagus. The species are parasitic in the intestine of Ruminants and the Pig.*

Globocephalus (Mol.). — Head spheroidal and diaphanous; buccal capsule sustained by two horny rings parallel to each other—one at the opening, the other at its depth—both united by four horny intermediate cornua; buccal orifice terminal and orbicular, the annular limb being entire and not dentated (Railliet). *One species in the intestine* of the Pig.

Sclerostomum (Blainv.).—Head truncated and straight, or slightly curved towards the ventral surface; mouth surrounded by sharp teeth—which are often numerous—and succeeded by a buccal capsule of variable shape. *Males* provided with two spicules, and a caudal pouch, which is frequently trilobate. *Females* have a double ovary, and the vulva is situated in the posterior part of the body (Railliet). The species are parasitic *in the intestine of the Horse*, and of small Ruminants.

Anchylostomum (*Anchylostomum* Dubini, *Dochmius* Duj., *Uncinaria* Frolich). — Head curved towards the dorsal surface. Buccal capsule horny; the dorsal wall being shorter than the ventral, is sustained by a conical line or rib, which sometimes projects by its point into the interior of the cavity. At the bottom of the capsule—on the ventral wall — are two sharp teeth or lancets; and towards its free border, on each side of the middle line, are chitinous plates or teeth, which are often curved in a hook-like fashion at their extremity; the dorsal border may be also dentated (Railliet). Several species infest the domesticated Ruminants and Carnivora.

Ollulanus (Leuck.).— One species in the Cat.

Trichocephalus (Gœze). — Anterior portion of the body capillary and very thin; posterior portion suddenly expanded, and somewhat thick and cylindroid. In the *males* the caudal extremity is coiled up. There are no lateral regions, only the middle lines; and there is a longitudinal papillary band on the ventral surface of the anterior region (Railliet). There are several species found in Ruminants, the Pig, Dog, and Rabbit.

Trichosomum (Rud.—see p. 279).—One species infests the *intestine of the* Sheep, and several others are found in domesticated Birds.

Trichina (Owen; *Trichinella* Railliet). —This genus only offers one interesting species—the *Trichina spiralis* Owen—which will be studied when the parasitic affections of the muscles are considered (see *Trichinosis*).

Fig. 158. — Lumbricoid Ascarid, male, lateral view; natural size.—Railliet.

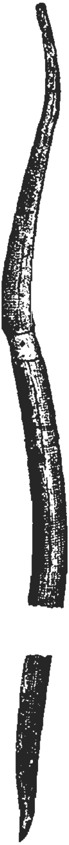

Fig. 159.—Lumbricoid Ascarid, female, ventral surface; natural size.—Railliet.

Filaria (Müller).—The Filariæ are more particularly parasites of the serous membranes and the subcutaneous connective tissue. They belong to the Worms that are very rarely met with in the intestine of the Horse and Dog.

Spiroptera (Rud. — see p. 279). — The *Spiroptera sanguinolenta*—the natural *habitat* of which is in the œsophagus of the Dog, Fox, and Wolf—has been on one occasion found in the intestine of a Cat (Railliet).

FIG. 160.—Cephalic extremity of a duodenal Anchylostome, viewed on the dorsal surface; highly magnified.—E. Perroncito.

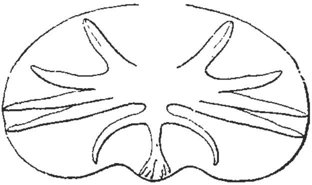

FIG. 161.—Caudal pouch of the duodenal Anchylostome; magnified fifty diameters. (Semi-diagrammatic.)

Angiostomidæ.—Grassi and Leuckart have allotted to the genus *Strongyloides* (Grassi) very small Nematodes which occur in the intestine of Man, the Sheep, Pig, and Rabbit, and which constitute so many different species. They are particularly interesting because of their metamorphoses, which have been more particularly studied on the species that is parasitic in Man.

Bavay has described—by the name of *Anguillula intestinalis* and *A. stercoralis*—two forms of Nematoda, the first in the small intestine, the second in the fæces of individuals affected with 'Cochin China diarrhœa.' Perroncito, Grassi, Parona, Leuckart, etc., have more recently met with them in other forms of *pernicious diarrhœa.* The intestinal Anguillula (or Thread-worm) is 2·2 mm. long and 34 μ thick; the *female* alone is known. The fæcal Anguillula is smaller, the *male* measuring ·7 mm. long and 35 μ thick; and the *female* 1 mm. long and 50 μ thick.

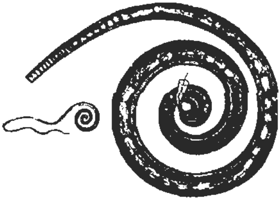

FIG. 162.—The Trichocephalus of Man, male; natural size, and posterior part magnified.

Grassi was one of the first to maintain that these two forms were one and the same species — the *Strongyloides intestinalis* (Bavay) —and that the second was merely the free state of the first, which represents the veritable parasitic generation. Leuckart expressed the same opinion about the same time, and Golgi and Monti have confirmed it. In a recent work, Grassi and Calandruccio have made known new peculiarities relative to these Nematodes.

The intestine of the living Man harbours only the form named *Anguillula intestinalis*—a Worm of female habits—and its embryos come from it, probably by parthenogenesis. It is oviparous or ovoviviparous, the ova promptly

yielding the young larvæ, which are expelled from the intestine of man along with the *fæces*. These larvæ—which are non-sexual, and very different from their mother parent—may have two widely diverse destinations; they assume the characters of the Intestinal Anguillula, or even those of the fæcal Anguillula — a more advanced stage. In the latter case, after copulation, the females bring forth a new generation of larvæ which are free, and being

FIG. 163.—Intestinal Anguillula, adult *female*.—*Grassi* and Parona.

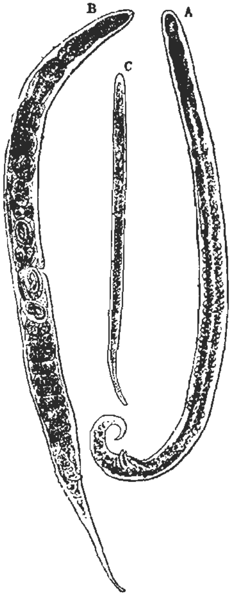

FIG. 164.—Fæcal Anguillula.—Perroncito.

produced by sexualized parents, external to the human intestine, do not attain maturity. They exactly resemble those mentioned above, comport themselves in the same manner, and after being ingested by Man are transformed into Anguillula intestinalis. Grassi has demonstrated that the larvæ produced by the latter also undergo this transformation, which brings them

into the condition of the individuals from which they have issued. But they only acquire maturity when they are placed in a favourable temperature. This is what has been observed in employing a stove, for instance, and not relying on the ordinary—even the summer—temperature.

Etiology of Intestinal Helminthiasis.—The presence of Helminthes in the intestine of various domesticated animals is of extreme frequency, and, in fact, may be said to be almost a normal condition in the Dog, Cat, Sheep, Horse, and Pig. The Ass and Mule are less infested, and less still are the Ox and Goat. Helminthes are very often found in Poultry.

The ancients, who did not suspect the origin of these Worms, formed the strangest hypotheses as to their formation. An examination of these ideas is full of teaching for the philosophy of science, but we do not propose to discuss this, and refer our readers to the works in which this information is to be found. It is now well established, by observation and experiment, that the Helminthes—or intestinal Worms—are always produced from ova, embryos, or larval forms, which have been derived by the host from without, and especially by means of the animal's food and water. It is entirely a chance meeting, but it becomes frequent and easy from the multitudes of germs that these Worms can furnish. The eggs are, in fact, often produced in millions by only one of these parasites. Von Siebold estimated at a million, at least, those of a single *Tænia solium*; Dujardin, at 25 millions those of a *Tænia serrata*; Eschricht, those of the *Ascaris lumbricoides* at several millions. This is a compensation for the innumerable chances of destruction that threaten these germs. Besides, the shell of the eggs 'is so impermeable and resisting, that it can only be affected by very energetic chemical agents; and in the majority of cases this shell is sufficient to protect the contents of the egg against everything that, in ordinary circumstances, might alter them' (Baillet). To this may be added the remarkable vitality with which the embryos are endowed. Verloren—cited by Baillet—kept, for more than a year, ova of the *Ascaris marginata*, in which the embryos—formed from the fifteenth day—remained alive, although they had been exposed to all the variations of temperature during summer and winter. Baillet has made similar observations on the eggs of another species of Ascarides; and he has also remarked that in these species the transformation of the vitellus into an embryo has sometimes not been perfected until after six, seven, and eleven months. He has seen embryos of the Tænia remain full of life in the eggs, when the segments containing them had been twenty-four hours in a thick layer of ice.

Independently of the conditions essential to the penetration of the germ into the organism, there may be others of a secondary kind which predispose individuals to intestinal helminthiasis. In general, everything that causes debility contributes to facilitate the installation of the parasites in the intestinal canal; and perhaps this may be due to the feebler peristaltic and antiperistaltic con-

tractions of the intestine. In any case, the Helminthes are met with much more frequently, and in greater numbers, in anæmic animals than in those which are vigorous, in young or very aged subjects than in those of middle life, and in those which are turned out to pasture rather than in those permanently kept in their habitations. Humidity has also, at all times, been considered as one of the most predisposing causes to the invasion of the economy by Worms. Rainy years are marked by the extension of various forms of helminthiasis in animals which graze; and these affections are also more marked among animals that frequent inundated pastures and swampy places, and the borders of lakes and ponds. This is explained by the ova being preserved in water, and by their destruction under the influence of prolonged drought, as well as by the necessity for a damp medium for the succession of evolutive phases of certain species. With regard to heredity, to which the ancients attributed so important a share in this etiology, all that can be accepted is that there may be transmitted —along with the lymphatic temperament—a certain predisposition to helminthiasis.

Contagion is rarely evident. It often takes place through the medium of a host specifically different from that in which the adult parasitic form is found. At other times it is masked by the more or less unknown phases which the worm must pass through externally, in order to pass from the embryonic condition to the definitive form. In dealing with each species, we shall give the details that are known with regard to this evolution.

Symptoms.—The intestinal Worms generally are nourished by the chymous matters contained in the digestive canal. But there are also those that attack the mucous membrane and abstract its blood, while others are lodged in its substance and there cause inflammation with exudation, and sometimes the formation of pus. Nevertheless, accidents attributable to these Worms are somewhat rare; and it is only when they have accumulated in great quantity that they excite morbid phenomena of various kinds. It is necessary, also, to take into serious consideration the zoological species and habits of the parasite, rather than its size.

Sometimes the course of the food is hindered and obstructed; at other times the digestion is disturbed and the appetite altered; intestinal catarrh of varied gravity may supervene; in some cases there is a pernicious anæmia by hæmorrhagic exhaustion, malnutrition, or there may be—though rarely—perforation of the intestinal membranes. Certain invaginations found at the autopsies of animals which have died, apparently from colic, may be attributed to Worms.

Chabert gave a singularly exaggerated picture of the symptoms by which helminthiasis of the intestine is manifested; but, generally, they have no precise signification. Those which seem to really pertain to it are an irregular appetite—sometimes voracious, some-

times indolent—depraved taste, dulness, and emaciation, notwithstanding an abundant alimentation; the skin is dry and adherent, and the hair erect; the flanks are sometimes tympanitic, sometimes retracted, or the abdomen is enlarged though there is general wasting; there may be constipation or diarrhœa; yawning, nausea, or vomiting; the breath fœtid, tongue furred and foul; sub-acute colic; spasmodic movements of the upper lip; nasal pruritus in the Dog, and anal pruritus in this animal and the Pig, manifested by their rubbing that part against hard bodies, or drawing it along the ground; sudden cries without any apparent motive, convulsions, rabiform symptoms, etc. With regard to epilepsy and vertigo—sometimes attributed to intestinal helminthiasis—there is nothing to prove that they are other than mere coincidences; and this remark applies to the singular theory of Stanley, who ascribes to worms the existence of 'stringhalt' among Australian Horses.

The numerous symptoms described as indicating enterohelminthiasis are scarcely ever seen altogether in one individual, and the diagnosis of this affection is generally difficult. But the presence of parasites in the excrements often renders this certain, and for several species of Helminthes a microscopical examination of the evacuations may lead to the recognition of the somewhat characteristic ova and embryos. Finally, there are symptomatic manifestations that properly belong to each kind of domesticated animal and to each species of parasite; these will be described *à propos* of the particular forms of helminthiases.

Treatment.—The prophylaxis of intestinal helminthiasis is necessarily vague, as we do not know the conditions upon which the development of the intestinal entozoa depend. The purity of food and of drink, the use of dry pastures, and the exhibition of a tonic nourishment, are almost the only general measures that can be recommended here.

Treatment consists in the employment of those medicaments named *vermifuges*, *vermicides*, and *anthelmintics*. Their action may be assisted by a special regimen. 'We advise giving to the Herbivora green food—in winter, carrots—frequently seasoned with salt; to Horses, roasted oats; to Dogs, as much flesh as possible, and a decoction of milk or of onions; to Pigs, clotted milk, skimmed milk, green fruit, and acorns' (Röll).

When debility is pronounced, it is well to add a regimen of tonic substances, such as bitters and common salt.

When there is colic or convulsions, we commence by giving appropriate medicines to allay them—bland oils, ether, opium, assafœtida, and extract of hyoscyamus.

The anthelmintic treatment should be preceded by half-diet for some days, and sometimes by slight purgation. A purgative may be added to the vermifuge, in order to expel the Worms which are dead or stupefied by the special drug; but it is preferable not to exhibit an evacuant until some hours after the administration of

the anthelmintic. Recourse is generally had to drastics, especially to aloes, and sometimes also to calomel or castor-oil.

Very many substances have been recommended for freeing the intestinal canal from its parasites; but some of them have an unwarrantable reputation, and it is best to employ those the efficacy of which has been well established. Those most frequently used are arsenious acid, tartar emetic, ferrous sulphate, sodium chloride, thymol, areca, santonin, the root of male fern—especially in the form of ethereal extract—tansy, benzine, empyreumatic oil, oil of turpentine, kousso, kamala, and various antiseptics.

Their indications, doses, and modes of employment will be given in the following articles, in which intestinal helminthiasis is studied successively in the various species of domesticated animals.

A.—DOMESTICATED MAMMALIA.

ARTICLE I.—Parasites of the Intestine of the Equidæ.

Globidium of Leuckart.—In the wall of the small intestine of a Horse killed for dissection, Max Flesch found, in considerable number, a microscopic parasite, which he named *Globidium Leuckarti*. Its presence had caused

FIG. 165.—*Tænia perfoliata*; natural size, but incomplete.—Railliet.

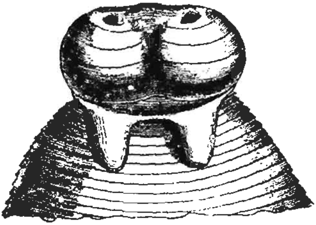

FIG. 166.—Cephalic extremity of the *Tænia perfoliata*; magnified twelve diameters.—Railliet.

slight and irregular inflammation of the organ. Its special location was the sustaining connective tissue of the intestinal villi, generally towards their middle portion, and immediately beneath the epithelium. A villus sometimes contained two or three of them.

The *Globidium* had the appearance of an elliptical or spherical capsule, with a well-marked outline, and 80 μ long and 70 μ broad In it were very refrangent spherical globules, averaging 13 μ in diameter; sometimes these were numerous and occupied the whole of its cavity, at other times they were exclusively parietal, and margined a central space filled with a mass of protoplasm. In the majority of the organisms, the wall was thickest at this point, and had a special cavity—fusiform or semilunar—filled with granular bodies,

and separated from the shining spheres just mentioned by a thin septum. Sometimes the internal cavity of the *Globidium* was exclusively occupied by another pyriform capsule, provided at its thin pole with a micropyle opening into the general enveloping cavity.

Max Flesch could not determine the course followed by the *Globidium* in reaching its seat of election, nor yet the zoological group to which it should be allotted. It appeared, nevertheless, to have analogies with the Sarcosporidia. Moniez considers the bodies found by Flesch as the embryos of a

FIG. 167.—*Tænia mamillana*; natural size. —Raillet.

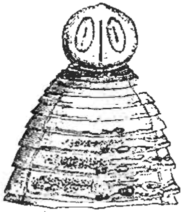

FIG. 168. — Cephalic extremity of the *Tænia mamillana*; magnified twenty-five diameters.—Railliet.

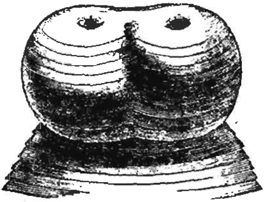

FIG. 169.—Cephalic extremity of *Tænia plicata*; magnified ten diameters.—Railliet.

FIG. 170.—*Tænia plicata*; natural size.—Railliet.

Tænia of the Horse, encysted in the papillæ, like those of the *Tænia murina* of the brown Rat. This is the only analogy in support of the hypothesis, which would require, in addition—in order to be acceptable—the presence of hooks on some at least of these bodies, and several other peculiarities of organization.

CESTODES.—Three species of Tæniæ have been found in the digestive canal of the Equidæ; all three are unarmed, and belong to the group of Anoplocephalinæ. Nothing whatever is known of their cystic form. The three species have in common—besides the absence of hooks and neck—a single genital pore in each segment, situated on the same side in all of the segments.

1. **Tænia perfoliata** (*Anoplocephala perfoliata* Gœze).—The length generally is 26 mm. to 28 mm.; but according to Rudolphi, it may reach 80 mm.; breadth 3 mm. to 15 mm. Head somewhat large—2 mm.—tetragonous and rounded, and also prolonged behind by four rounded lobes; suckers cupuliform and directed forwards. Segments thick, but very short, and becoming wider to about the middle of the length of the body; they succeed each other like leaves, one overlapping the succeeding one, to which it only adheres at a middle transverse line; the last segments are always sterile. Ova polyhedral by reciprocal pressure; they measure about 80 μ broad; the embryo—which is 20 μ in diameter—has its shell prolonged by an elongated blunt point, that represents the pyriform apparatus of the other Anoplocephaliens.

2. **Tænia mamillana** (*Anoplocephala mamillana* Mehlis).—Length 1 cm. to 3 cm., breadth 4 mm. to 6 mm. Head tetragonous, obtuse, ·5 mm. long, and ·8 mm. broad; suckers lateral, elongated, opening in a longitudinal slit. The segments are 30 to 40, sometimes 50 in number; the first are curved in half-circles, and embrace the base of the head; those which succeed these widen rapidly, and soon acquire their maximum breadth; their length increases, on the contrary, to the posterior extremity, where—in the last segments—they may exceed the half of their breadth. Ova oblong, and 88 μ in length, 50 μ to 66 μ in breadth; the embryo has the same dimensions and appearance as that of the preceding species.

3. **Tænia plicata** (*Anoplocephala plicata* Rud.).—Length $1\frac{1}{2}$ cm. to 8 cm., breadth 8 mm. to 18 mm. Head very thick, short and broad—4 mm.—slightly depressed from one face to the other of the Worm; suckers cupuliform and directed forward. Segments regularly increasing in length and breadth to the last, which may be 1·5 mm. long. Ova round or polyhedral.

The *Tænia* or *Anoplocephala perfoliata* more especially infests the cæcum, and is but rarely found in the colon or small intestine. The *T. mamillana* is met with in the small intestine, less often in the duodenum than in the ileum and jejunum. The *T. plicata* lives in the small intestine, and is sometimes seen in the stomach.

None of these three species is common in France, and the last two—and particularly the *Tænia plicata*—are altogether rare. We have only once met with Tæniæ in the Horse. They belonged to *T. perfoliata*, and were found—to the number of 104—in the last portion of the small intestine of a Horse that came from the mountainous parts of the Hautes-Pyrénées. The Tæniæ of the Horse are more common in Germany, and still more in Russia. In the latter country, according to Blumberg, they are encountered—on the average—in one of every ten Horses. Greve says he has seen thousands of *Tæniæ* in the small intestine of the Horse. In about 100 Horses, Krabbe, of Copenhagen, has f und *Tænia perfoliata* in 28, and *T. mamillana* in 8; but in none of them did he see *T. plicata*. The *T. perfoliata* averaged 25 in number; in two animals they were between 200 and 300, and in one 400. The *T. mamillana* numbered, on the average, 25; 72 was the maximum. The observations of Hering, made at Stuttgart, fairly agree with those of Krabbe, except that the Tæniæ in the Horse are much less frequent, and the *T. plicata* is less rare. Sarciron has found hundreds of *T. plicata* in an Ass's foal in Senegal; Beugnot—quoted by Railliet—has also met with them in a Mule at Gabès, Tunis. Krabbe, in his description of the Cestodes collected by Fedschenko during his travels in

Central Asia, remarked that *T. mamillana* of the Horse was more rare than *T. perfoliata* (Zschokke).

The existence of Tæniæ in the Horse generally remains unperceived during life, though sometimes it coincides with the general symptoms of intestinal helminthiasis, or rather with anæmia. At the autopsy of a Mare which had died suddenly, Poulton found numerous Tæniæ in the duodenum, and in large pouches formed in the wall of other parts of the small intestine. Mégnin also reports two observations relating to Horses which died of peritonitis caused by the rupture of intestinal dilatations, in the interior of which were found *T. perfoliata*. Perroncito gives an analogous instance. At the autopsy of a Horse that was killed because of anæmia after paralysis, Hürlimann found such a quantity of *T. perfoliata* (?) that they filled a large basket.

TREMATODES.—Two species of Trematoda—strangers to our country—have been met with in the Equidæ—the Amphistome of Collins, and the Egyptian Gastrodiscus.

Amphistome of Collins (*Amphistomum Collinsi*, Cobbold).—Worms of a brick-red colour, known for a long time to the natives of India by the name of *Masuri*, which live in thousands in the large intestine of the Horse, where they are capable of producing serious intestinal irritation. Besides this form, Cobbold has described another—*A. Collinsi*, var. *Stanleyi*.—Railliet.

Gastrodiscus of Egypt (*Gastrodiscus Ægyptiacus* Sonsino and Cobbold).—Body flattened into an elliptical disc, the dorsal surface being convex and smooth, and the ventral surface concave and covered with about 200 papillary suckers. The buccal sucker—smaller than the posterior sucker—is situated at the end of a cylindro-conical neck, and is salient on the dorsal surface, with which it forms a wide obtuse angle behind. This neck is about 2 mm. or 3 mm. long. The body is discoïdal, about 10 mm. to 12 mm. in transverse diameter. Most frequently the antero-posterior diameter is about 1 mm. more than the other. The colour is rosy in the fresh state, and pure white after immersion in alcohol. Like the Amphistomes, this parasite fixes itself on the mucous membrane by its posterior sucker.

FIG. 171. — *Gastrodiscus Ægyptiacus*; natural size.—Railliet.

A, ventral surface; B, dorsal surface

It was discovered in Egypt, in 1876, by Sonsino, at Zagazig, near Suez, in two Horses of fifteen which had succumbed to an enzoötic affection. In one Horse he found six specimens in the small intestine; in the other, about 100 in the large intestine. The study of these worms was made by Cobbold and by Lejtényi—a pupil of Leuckart. The Gastrodiscus has since been found several times in Egypt, notably by Burlazzi and Zuchinetti; and in Senegal by Sarciron. Another country afflicted with this parasite is Guadeloupe, where it has been discovered on three occasions by Guyot—at Pointe-à-Pitre, in 1880; and twice by Veterinary Surgeon Couzin, who has sent us numerous specimens from Moule.

Egypt, Senegal, and Guadeloupe are, then, the only countries in which the Gastrodiscus is at present known. In Egypt it is found in Horses; in Senegal it is met with in Ass foals; and at Guadeloupe it is observed in Mules. In the first cases the autopsies did not reveal any lesion which could be attributed to it. At Guadeloupe, death occurred suddenly (Guyot), or after a long period of anæmia (Couzin). A remarkable feature in the history of this parasite is that its habitat is not particularly localized. In the Mules at Guadeloupe it was found in thousands, from the pharynx to the anus, and even in the nasal fossæ (Guyot); or in the stomach, cæcum, or second section

of the large colon (Couzin). The Mules had been fed on green forage and treacle, and it is probable that they had taken the larvæ of the Gastrodiscus along with this aliment, in the form of germinal sacs or cercariæ.

NEMATODES.—The **Ascaris megalocephala** (Cloq.), *As. equorum* Gœze, is special to the Equidæ. It is the largest species in the genus.

Its body is yellowish-white and rigid. The head is distinct, and has three lips, which are constricted in their middle, and have comparatively large teeth on their free margin. The *male* is 15 cm. to 28 cm. long; its tail is bordered by two small membraneous wings, and has on each side 79 to 105 papillæ, 7 of which are post-anal; the fourth and fifth of these, as well as the sixth and seventh, are joined to form one; there is a single papilla in front of the anus, the other pre-anal papillæ are arranged in a single, then in several rows. The *female* is 18 cm. to 37 cm. long; the vulva is situated towards the anterior quarter of the body. The ova are nearly globular, and have a diameter of 90 μ to 100 μ.

The Ascaris megalocephala or *equorum* is common in the small intestine of the Horse, Ass, and Mule; but its presence does not usually affect the health of the host, though in young animals it may give rise to various troubles in digestion. Beyond the symptoms common to the various intestinal helminthiases, there is often remarked a chronic catarrh of the intestine—a slight but obstinate diarrhœa—the expulsion of the fæces being immediately preceded by a discharge of fluid from the intestine. In France, Horses so affected are called 'vidards,' and sometimes they pass these worms along with the excrements. Colic is often a consequence of an obstruction of the intestine, which may persist and eventually cause death. Symptoms of vertigo and epilepsy have also been observed. Dieckerhoff relates the case of a Horse that gave indications of attacks of intermittent tetanus, which were repeated several times a day, and lasted for about a minute each time. It was a kind of emprosthotonos, involving the head—jaws, lips, eyes—neck, and the upper parts of the anterior limbs, while the head was strongly flexed downwards. These symptoms disappeared after the administration of a suitable dose of tartar emetic and aloes, and the consequent evacuation of 21 Ascarides. Damitz had observed a kind of paraplegia that yielded to the administration of anthelmintics.

Ascarides are found in the small intestine of Horses which, during life, gave no indication of their presence. Krabbe, of Copenhagen, has met with them 16 times in 100 Horses he examined. The number of individuals living in the same host is very variable—there may be only a few, but often they are counted by hundreds. At the Brussels Veterinary School, in one Horse there were more than 1,800; and Delamotte has found 1,215—weighing collectively 3·250 kilogrammes—at the autopsy of a Mare which died of sclerosis of the heart. They are often massed in bundles, and rarely rolled up on themselves. They infest various parts of the small intestine, and particularly the duodenum; but when they are numerous

they may also pass into the stomach—Röll has even, on one occasion, found them in the bile-duct. In a Horse which had died from pneumonia, Generali came upon an Ascarid that had found its way into the anterior part of the pancreatic duct, which was very dilated and its walls thickened—proving that the worm must have been there a considerable time before death.

At the autopsy of animals which have died of verminous colic, there are often observed all the signs of anæmia, and always those of more or less severe intestinal congestion in various parts of the small intestine infested by the Worms; it is not even rare to meet with ruptures of the intestine, undoubtedly due to obstruction and softening brought about by its congested condition, and the violent struggles of the animal when suffering from the colicky pains. The contents of the viscus escape into the peritoneal cavity, and among them are seen floating some Ascarides which have passed through the rent; peritonitis has precipitated the fatal issue.

Gavard was probably mistaken when he asserted he had found numerous Ascarides in the peritoneal cavity, without any rupture of the intestine. The consequences of such a rupture are sometimes delayed, and the Ascarides pass through it to between the two layers of the mesentery, where they form a large pouch that becomes inflamed, and finally opens into the peritoneal sac. Wira has reported an instance of this; and Zorn has described two analogous cases, in which the communication of the intestine with the mesenteric pouch took place through small openings with callous, thickened borders. But it cannot be affirmed that in these two instances the perforations were directly produced by the Ascarides. Generally it is only a question of old or recent rupture; but in some published observations the characters of the accidental opening—its circular shape, small diameter, and an Ascarid sometimes fixed in it—are so many circumstances which ought to lead to the belief that it is in reality a perforation. It is possible that the Ascarides attack the mucous membrane with their dentated lips, and induce a local inflammation in it, which ends in ulceration.

The conditions under which animals receive the germs of their Ascarides are not known. The persistency of the latent vitality of the ova, the resistance of the embryos to causes of destruction, and the influence of humidity in the development of these embryos, render it very probable that the Worms are introduced in the form of ova or embryos into the digestive canal with the food or water. It is therefore indicated, as a preventive measure, to allow only water as pure as possible to be taken, and to destroy by fire the Worms which are evacuated. If they are permitted to find their way to the manure-pit, of the millions of eggs they contain some may meet with the conditions favourable to their evolution, and so infest other Horses, Asses, or Mules. In any case, helminthiasis by Ascarides ought never to be neglected, but should always be combated by an appropriate vermifuge.

Arsenious acid answers well. It is given in the food in increasing

doses of 1 to 3 grammes a day, for ten days. Tartar emetic has also been highly recommended, in doses of 15 to 20 grammes per day, in four doses at three or four hours' interval, either in bolus or electuary along with gentian powder, or mixed with assafœtida and empyreumatic oil. On the following day an aloetic purge is given. Zundel has been very successful with juniper berries and cream of tartar—given in a little damp bran—for fifteen days, after which a dose of aloes is administered. Oil of turpentine may also be employed—80 to 150 grammes made into an emulsion with linseed oil; powdered santonica 100 to 150 grammes, empyreumatic oil 20 to 30 grammes; or benzine 50 to 100 grammes. Ferrous sulphate and sulphate of copper are often successfully employed.

It ought to be stated that, in many cases, all these remedies are insufficient, and that a specific against the Ascarides of the Horse has yet to be found.

Curved Oxyuris (*Oxyuris curvula* Rud.) (*O. equi* Schrank.).—The *female* of this Worm (commonly known in England as the 'maw worm') is almost exclusively met with. It is 40 mm. to 50 mm. long, is arched in its anterior portion, more or less subulated behind. The vulva is situated about 10 mm. from the mouth. The eggs are ovoïd, from 88 μ to 95 μ long, and 41 μ to 45 μ broad, asymmetrical, and carrying at one of their ends—which is truncated—a kind of operculum. In this species, the head has

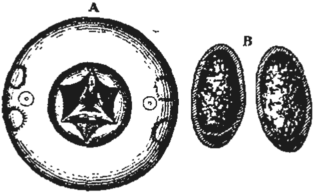

FIG. 172.—Oxyuris of the Horse.

A, *anterior extremity, seen in front.*
B, eggs; magnified about 200 diameters.

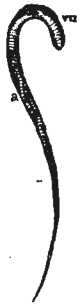

FIG. 173.—Oxyuris of the Horse, female; natural size.

vu, vulva; *a*, anus.

no lateral wings; the mouth presents three great rounded lips, each of which envelops two mamelons; there are six papillæ in two opposite groups. The *male*, very rare, has been described by Railliet. It is 9 mm. to 12 mm. long; the posterior end is obtuse and has several papillæ, the longest of which sustains a kind of caudal pouch, which is well developed; the spicule is straight, thin, and very sharp.

The curved Oxyuris is met with throughout the length of the large intestine of the Equidæ; but, according to Colin, its usual habitat is the diaphragmatic flexure of the large colon. It is

sometimes seen partly projecting from the anus, to the margin of which it is fixed; or it may be observed in the fæces. Effects analogous to those of the *Oxyuris vermicularis* of Man have been attributed to this worm—burning sensation, anal pruritus, and tenesmus; the margin of the anus is red and swollen, and the animal's tail often agitated. But, on the whole, the worm appears to be very inoffensive; though we have mentioned that Pflug attributed a very pruriginous eruption observed on a Horse to embryos of the curved Oxyuris. Nothing is known of its migrations, nor yet whether it has to undergo any.

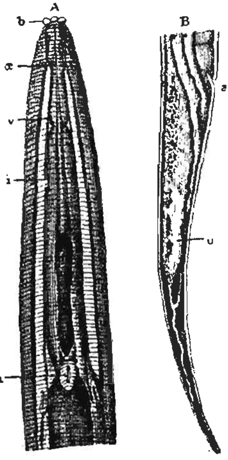

FIG. 174.—*Oxyuris of the Horse,* female.—Delafond.

A, anterior extremity, with the point laid open longitudinally; B, caudal extremity: *b*, mouth with the lips spread out; *a*, anterior part of the oesophagus or anterior bulb; *v*, ventricle or posterior bulb; *i*, intestine; *a*, anus; *u*, uterus; *vu*, vulva.

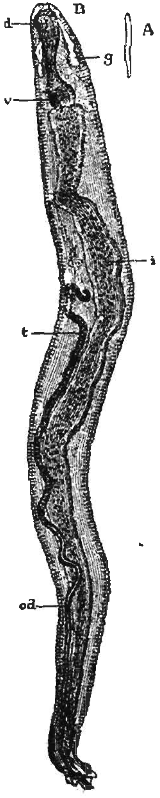

FIG. 175.—*Oxyuris of the Horse* male.—Railliet.

A, natural size; B, magnified: *d*, anterior bulb; *v*, posterior bulb or ventricle; *g*, the so-called salivary glands; *i*, intestine; *t*, testicle; *cd*, deferent canal.

Long-tailed Oxyuris (*O. mastigodes* Nitzsch).—This form—which had been already seen by Delafond—was first described by Nitzsch, then by Friedberger, each of whom found it in the fæces of a Horse. Blaise in Algeria and Condamine in France have also observed it in the same conditions. The description is applicable to the females, which are distinguished from those of the *Oxyuris curvula* by their length—13 cm. to 15 cm. The tail is long, thin, and smooth, and from three to four times longer than the body. The mouth is round and nude. The integument is finely striated transversely; the colour is brownish, due to the ova which fill the dilated anterior part. The vulva is situated in front of the middle of this part of the body. The eggs are ovoid and elongated, and sometimes contain embryos already de-

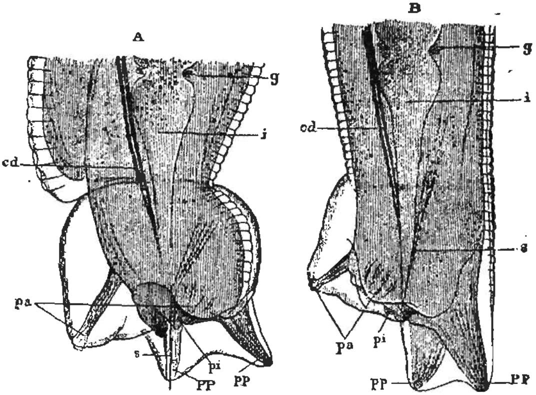

FIG. 176.—Caudal extremity of the male Oxyuris of the Horse.—Railliet.

A, ventral surface; B, left side: *i*, intestine; *g*, rectal glands; *cd*, deferent canal; *s*, spicule; *pa*, anterior papilla; *pp*, posterior papilla; *pi*, intermediate or cloacal papillæ.

veloped. According to Railliet, the long-tailed Oxyuris is only an abnormal form of the *O. curvula*—a simple case of dimorphism of the females. Intermediate forms are found (Figs. 177, 178).

In Friedberger's case, a mare which, for two years, showed obscure symptoms of helminthiasis. Every morning during the nine days of treatment, it passed bundles of 10 to 25 worms, all held together by a very viscid substance to the surface of the pellets—never in their interior—and always empty of their eggs.

Viviparous Oxyuris (*O. vivipara* Probstm.).—This worm should belong to the genus Strongyloides.

Sclerostomes.—Two species of Sclerostomum inhabit the large intestine of the Horse—the **Sclerostomum equinum** and the **Sclerostomum tetracanthum.**

Armed Sclerostome (*Sclerostomum equinum* Müller, *Scl. armata* Dujardin, *Strongylus armatus* Rud.).—Body grey, or brown shaded with red; straight, rigid, the anterior part being broader than that which immediately follows. Mouth orbicular, widely open, and rendered tense by several chitinous concentric rings, the innermost of which are garnished with fine teeth, while the outermost carry six papillæ symmetrically divided. The buccal capsule is sustained by a dorsal longitudinal line or rib, and has at the bottom two round sharp plates. The caudal pouch of the *male* is almost trilobate, the posterior ribs being trifurcated, the middle double, and the anterior cleft. The tail of the *female* is obtuse, and the vulva is situated in the posterior moiety of the body. Eggs ovoïd, and 92 μ long, 54 μ broad. The dimensions are variable; sometimes the males are 18 mm. to 20 mm. long, and the females 20 mm. to 26 mm., and at other times they are respectively 26 mm. to 35 mm. and 35 mm. to 55 mm.

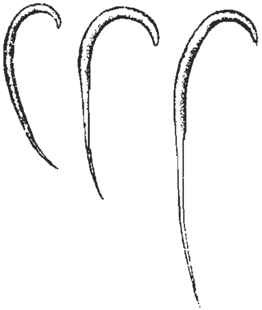

FIG. 177.—Oxyuridæ of the Horse; females with comparatively short tails, corresponding to the *curvula* form of the authorities; natural size.—Railliet (inedited).

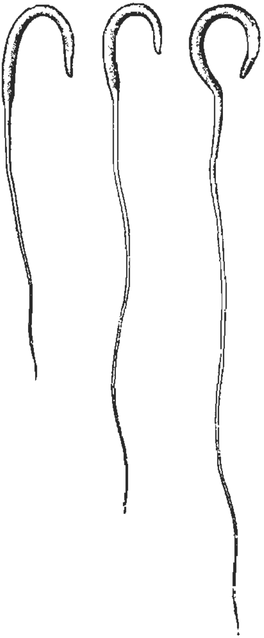

FIG. 178.—Oxyuridæ of the Horse; females with gradually longer tails, corresponding to the *mastigodes* form of Nitzsch; natural size.—Railliet (inedited).

The *Sc. equinum*—which is also often named the *armed Strongyle* and *palisade worm*—infests the cæcum and first part of the large colon, and—with the *Ascaris megalocephala*—is the worm most commonly found in the Equidæ. 'They are easily procured in Paris,' says Dujardin, 'and I have seen them at Toulouse and

at Rennes in the intestines of all the Horses I examined ; nevertheless, at the Vienna Museum only 17 Horses of 92 had them. Rudolphi found them very plentifully at all seasons.' At Copenhagen, of 100 Horses examined by Krabbe, 86 had this worm, and in some of these the large intestine was studded with them. Chabert counted more than 1,000 on a surface of two inches, and he estimated the total in one Horse at more than a million. Blumberg, at Kazan (Russia), only found them four times in 93 Horses ; and Duncan, at Toronto (Canada), met with them only once in 50 Horses.

The armed Sclerostomes hold firmly by their buccal armature to the mucous membrane, which forms at the point of adherence a small dark prominence. They

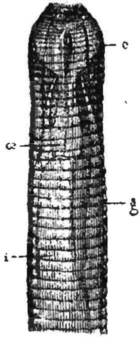

FIG. 179.—Anterior extremity of the *Sclerostomum equinum*.—Delafond.

c, buccal capsule ; *œ*, œsophagus ; *g*, one of the so-called salivary glands ; *i*, intestine.

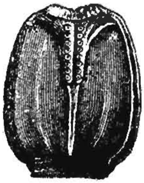

FIG. 180. — Dorsal moiety of the buccal capsule of the *Sclerostomum equinum* ; internal surface. — Delafond.

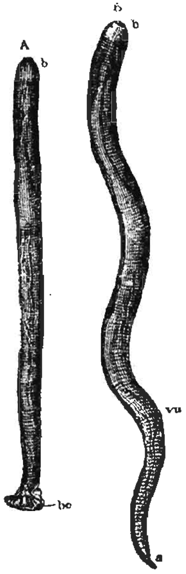

FIG. 181. — *Sclerostomum equinum*, agamous individuals from the pancreas ; magnified three diameters.—Delafond.

A, male ; B, female ; *b*, mouth ; *a*, anus ; *vu*, vulva ; *bc*, caudal pouch.

are frequently met with coupled—the two individuals forming an almost right angle, and adhering so intimately that they may be preserved in this condition in alcohol. Notwithstanding their considerable numbers, and the irritation they should produce

in the mucous membrane, their presence in the Horse is rarely betrayed by any appreciable symptom. They have sometimes been accused of causing death by anæmia, diarrhœa, colic, etc. (See *Parasites of the Circulatory Apparatus*.)

It is not only on the internal surface of the large intestine that they are met with, for they are found in aneurism of the mesenteric artery, and in the hepatic, renal, spermatic, occipital, and other arteries; in the muscles, pancreas (Goubaux, Montané), ligaments of the liver, and in submucous cysts of the cæcum, and sometimes of the duodenum. In all these instances they are in an agamous state, and represent a phase of the development of the species. In connection with the parasitism of these various organs, and especially of the circulatory apparatus, this feature will be more particularly examined; so that we shall only refer here to what is necessary to be known with regard to the migrations of these Helminthes.

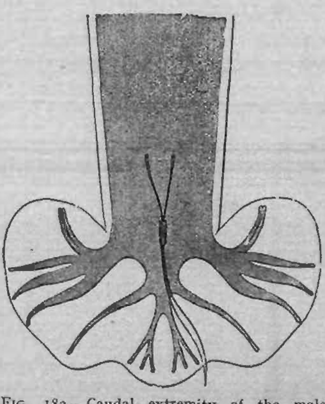

FIG. 182.—Caudal extremity of the male *Sclerostomum equinum*: magnified thirty diameters.—Railliet (inedited).

With regard to the intestinal tumours, their volume varies from that of the head of a pin to that of a hazel or small almond-nut, according to the development attained by the worm inside each tumour. The latter also contains altered blood or pus, and there is more or less hyperæmia around the circumference. The worm within is rolled upon itself, and is, of course, of variable dimensions—sometimes extremely fine, and never so large as in the adult state; it is always destitute of reproductive organs. Occasionally there is no worm in the tumour, and then there is seen a small opening at the summit, by which it has escaped. The worms found in the organs mentioned above are also agamous; they represent the primary phase of development, as they do not become sexualized except in the cæcum and colon.

Colin states that the armed Sclerostomes are worms which migrate internally, and that their development is effected almost in one place. The ova are deposited in the substance of the intestinal mucous membrane—perhaps in the punctures produced by the

mouth of the female, or perhaps merely in the orifices of the glands—and they are hatched there, the embryos becoming encysted at the points where they are hatched, in the cysts developed by their presence.

After being developed and having undergone several moultings, they leave their cysts, and fix themselves on the surface of the mucous membrane; though a certain number continuing in their cysts, grow there, have the genital organs partly formed, but nevertheless always remain agamous. Those found in aneurisms and in the peri-intestinal organs must, on leaving their cysts, have

FIG. 183.—Fragment of the Cæcum of a Horse, showing the tumours of different sizes due to the Sclerostomes, as well as the parasites fixed on the mucous membrane. To the right are the two varieties of the *Scl. equinum*, to the left those of the *Scl. tetracanthum*; natural size.—Railliet.

entered the bloodvessels, and been carried—by a centrifugal migration—to the parts where they are found.

Baillet has shown that this is not the ordinary mode of reproduction and development of the Sclerostomes. The ova are expelled along with the fæces, and become hatched in a few days if they are in a damp place. The embryos that issue from them are cylindroïd, a third to a fourth of a millimetre long, somewhat obtuse in front, and have a filiform tail. If the conditions of humidity continue to be favourable, they gradually grow, their integument becomes folded and forms a kind of sheath in which the worm moults in an evident manner. Baillet has been able to keep

them several months in this state, or after complete moulting. It is at this *period that they enter the body of the Horse in the* drinking water, or perhaps on green forage, undergo moulting if they have not already done so, and penetrate the substance of the mucous membrane. Leuckart asserts that the embryos should pass through an intermediate host before entering the intestine of the Horse. But however this may be, it is possible that after they have lodged themselves in the mucous membrane, a small number of embryos stay to fix themselves in cysts which they cause to be formed. The majority reach the circulatory system, and install themselves in the abdominal arteries—principally at the origin of the great mesenteric; there they form aneurismal dilatations, filled with a ragged clot that adheres to the inner surface of the vessel, and in this the Helminthes are located. There they acquire a length of 3 cm. or 4 cm., and commence to be sexually differentiated, but remain agamous. These verminous aneurisms play an important part in the etiology of colic.

After a more or less prolonged sojourn in the aneurism, the worms leave it, and carried by the blood, in the course of time reach the cæcum, where they form the majority, if not the whole, of the submucous cysts. Their last migration is, therefore, in reality, centripetal.

Finally, after having rested more or less long in the tumour, and having grown, the parasites forsake it, attach themselves to the mucous membrane, become sexualized, and copulate.

An interesting observation of Railliet gives support to this theory of the development of the Sclerostomes. He found in a Horse a considerable quantity of these worms in the cæcum, and some verminous cysts, numerous in the walls of that viscus, and a smaller number in the duodenum and other parts of the small intestine.

The cysts in the duodenum—which are rare—were all grouped on the small curvature of the intestine, and some were even observed disseminated in the mesentery. All the latter contained Sclerostomes still agamous; but several of those in the small intestine—like those of the cæcum—had an opening in their centre and were vacant, the Helminthes having left them. This would seem to prove that the worms had reached the intestine by way of the arteries.

We ought at least to mention the opinion given by Willach, on the phases of development of the Sclerostomes. He found in the intestine of the Horse—independently of armed Sclerostomes having the usual dimensions—small worms *7 mm. to 12 mm. long, which he believed were of the same species*, by reason of the shape of their cephalic extremity. Some were manifestly females, and contained numerous eggs having a thin shell, and measuring 80 μ long and 40 μ broad. Others had a caudal pouch similar to that of the adult armed Sclerostome, and had, in addition, eggs like those of the females just described, but less numerous. Therefore these worms were hermaphrodites; one even showed, alongside the mature eggs, embryos ·5 mm. long. Willach consequently admits that the armed Sclerostome has an intermediate phase of development—a rhabditiform generation, issuing on the spot in the intestine of the Horse, from the well-known normal worms. The female

rhabditiform Sclerostomes also deposit their eggs on the same place; but with the hermaphrodites—which have no vulva—the embryos are hatched in the body of the parent, and they only escape therefrom by the destruction of the internal organs, caused by their movements. These embryos, expelled outwards or continuing their development in their first host, become eventually normal Sclerostomes. This theory of Willach requires new observations before it can be adopted.

Sclerostomum tetracanthum (Dies.) (*Strongylus tetracanthus* Mehlis).—This worm is distinguished from the preceding species by its smaller dimensions—the *males* being sometimes 8 mm. to 10 mm., and at others 12 mm. to 15 mm. long; while the *females* are 10 mm. to 12 mm. or 14 mm. to 17 mm. in length. Their colour is whitish, and the body is slightly tapering anteriorly. Mouth circular, with a salient rim that has a crown of triangular teeth, and outwardly six papillæ—two lateral, small, and on each side of them two others, conical and very prominent. Buccal capsule cylindrical; two long lateral papillæ a little in front of the termination of the œsophagus. The caudal pouch of the *male* is simply excised on the ventral surface, the posterior lines or ribs are trifurcated, the middle doubled, and the anterior cleft. The *female* has the tail terminating in a point, and the vulva very near the anus. The eggs are ovoïd, and 100 μ long by 48 μ broad.

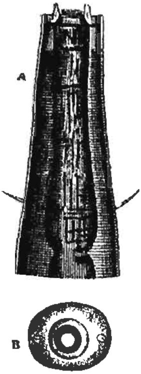

FIG. 184. — Anterior extremity of the *Sclerostomum tetracanthum*: magnified ninety-three diameters.—Schneider.

A, dorsal view; B, front view.

The Sclerostomum tetracanthum also inhabits the cæcum and colon of the Equidæ, often in company with the preceding species, with which it is often confounded. It is usually free among the intestinal contents, and is frequently found coupled. The ova—like those of all the Sclerostomes—are segmented in the uterus; they are laid in the intestine of the host. The external phases in their development are, according to Baillet, analogous to those of the armed Sclerostome. The embryos are thicker, the tail is longer, and their movements less active. They are introduced into the intestine with the water the host drinks, and it is probable that they encyst themselves directly in the mucous membrane, without penetrating the circulatory apparatus—at least, no wandering parasites of this species have ever been observed. The tumours they form beneath the mucous membrane are of the same character as those of the other species. Probstmayer, Leuckart, and Cobbold have exclusively allotted to the *Sclerostomum tetracanthum* the agamous worms found beneath the mucous membrane of the cæcum. They are generally considered inoffensive, but some observations show that, by their large number, the verminous tumours of the intestine may induce a serious, even fatal, anæmia; and that this species of Sclerostomum when free and numbering several thousands in the intestine, may be capable of producing a hæmorrhagic enteritis and fatal colic.

Other Nematodes.—We here and there find mention made of other Nematodes that have been met with in the intestine of the Equidæ. Thus, Rudolphi speaks of having seen there, in the Horse, the *Filaria papillosa* Rud., which is almost exclusively a parasite of the splanchnic serous cavities.

Cobbold mentions a *Trichonema arcuata* as being found in the large intestine of the Horse; but at a later period he recognised it as the larval form of the *Sclerostomum tetracanthum*, and considered it as identical with the *Nematoidcum equi caballi* Diesing, which has the same habitat.

Probstmayer and Perroncito have described, under the name of *Oxyuris vivipara*, worms found in abundance—by millions, Perroncito says—in the cæcum and large colon of the Horse; but according to Railliet, these are only species of strongyloides. They are small female worms, much resembling Oxyuris, 2·5 mm. long, and ·40 mm. to ·80 mm. broad, the uterus showing only a few ova containing embryos in various stages of development.

Lastly, Schlotthauber has designated by the name of *Piguris* (?) *reticulata* a worm he found in the cæcum of the Horse and Mule.

We have no further information concerning these worms, the authenticity of which is at least doubtful, and the importance of which is surely small.

Larvæ of the Dipteræ.—According to Cobbold, on several occasions larvæ of the hanging Helophilus (*Helophilus pendulinus* Még.) have been discovered in the digestive canal of the Horse. They are harmless.

The larvæ of the Gastrophilus, in process of evacuation, have also been observed in the intestine of the Equidæ. It has been stated, that those of the hæmorrhoidal Gastrophilus stay in the last portions of the large intestine, attaching themselves to the mucous membrane; while those of the nasal Gastrophilus prefer to develop in the pyloric region of the duodenum, and are, therefore, likely to hinder the passage of the alimentary matters and give rise to colic.

Observation.—The various parasites which have been passed in review may be combined in more or less large numbers, and occasion a complex helminthiasis. The most remarkable instance of this kind is that which Krause has reported. In a horse were found 519 *Ascaris megalocephala* or *equorum*, 191 *Oxyuris curvula*, 214 *Sclerostomum equinum*, several thousands of *Sclerostomum tetracanthum*, 69 *Tænia* (*anoplocephala*) *perfoliata*, 287 *Filaria papillosa*, and 6 *Cysticercus fistularis*.

Article II.—Parasites of the Intestine of the Ox.

Fungi.—The Ox is one of the number of Herbivora in which Remak—and after him Purkinje, Bœhm, and Mitscherlich—found, in the normal intestinal mucus, the *Saccharomyces* (*Cryptococcus*) *guttulatus* Robin. It is a very simple fungus in the form of ellipsoïd or ovoïd elongated cells, from 15 μ to 24 μ long, and 5 μ to 8 μ broad, dark brown and opaque, and containing two to four bright, transparent droplets. These cells are sometimes united in a confused mass by mucus; but they are usually isolated, arranged in twos—end to end—or one of the largest has at one of its poles two or three smaller cells which have been derived from it by gemmation. This fungus appears to have no action on the animals in which it is found.

The *Aspergillus fumigatus*—a mould which is developed more frequently in the respiratory passages of Birds—has been found several times by Franck in the wall of the small intestine, and in the mesenteric glands of cattle killed for food. It had caused the formation of caseous or calcified centres, which attained the volume of a pea, and were filled with pus containing the filaments of a mycelium that inoculation experiments and cultures demonstrated to belong to the *Aspergillus fumigatus* Fresenius.

Coccidia.—The Ox may be affected with an intestinal Coccidiosis caused by the *Coccidium Zurni* (Rivolta). Recognised for the first time by Zurn in

Calves, it has been described by Zschokke and by Hess in Switzerland under the name of '*Dysenterie rouge*,' and since studied by McFadyean and by Degoix.

The principal symptoms consist in more or less high fever, inappetence, cessation of rumination, emaciation, diminished secretion of milk, weakness of the hind quarters, swelling of the eyelids, redness of the conjunctivæ, and later pallor of the visible mucous membranes. The essential sign is furnished by diarrhœa, which is sanguinolent at the outset, or becomes so in a few days. There is often straining, with sometimes prolapse of the rectum.

This disease occurs at all periods of the year, but more particularly in the warm season in animals at pasture. It never attacks sucking Calves, and rarely animals less than a year or more than two years old.

The course of the disease is usually acute, rarely subacute. Recovery may take place in about eight days, but more often not before two or three weeks. Sometimes the attack is sudden and severe, and the affected animals die in twenty-four hours in convulsions. In certain districts of Switzerland it attacks 5 per cent. of bovines and kills 2 to 4 per cent. of those affected. In Burgundy the mortality has reached 25 per cent. of the animals attacked.

The inflammation may involve the whole length of the bowel, and even include the abomasum, but the parasitic lesions are localized more particularly in the large intestine from the cæcum to the anus.

The mucosa is brownish-red, œdematous, covered by a sanguinolent mucus, and studded with yellowish or greyish resistant patches, which may attain several centimetres in diameter. These lesions become more numerous and more serious as they approach the rectum. The patches formed by various pathological elements always enclose abundant coccidia, which may be found even before death in the mucus and fæcal matters. The coccidia are developed exclusively in the epithelial cells of Lieberkuhn's glands, where they may be found in various stages more or less advanced.

Coccidium Zurni in the state of *oocyst* is ovoïd, measuring 18 to 25 μ long by 13 to 18 μ broad, and sometimes more. It develops according to the generic type; and no doubt multiplication of the parasite takes place in the intestine of the host by Schizogenesis.

The Prophylaxis consists in the exclusive use of dry fodder and of pure drinking water. The Treatment is chiefly dietetic: mashes, gruels, milk, and a little good hay.

Sodium hyposulphite, sublimed sulphur, cresyl and lysol are the agents recommended (Hess).

CESTODES.—Like the Equidæ, Cattle harbour three species of unarmed Tæniæ. These are typical Anoplocephaliens, the genital pores of which are double on each segment, and the ova are irregularly polyhedral or cuboïd, showing the embryo surrounded by a pyriform apparatus (Fig. 185). These three Tæniæ are altogether unknown in their cystic form.

1. **Tænia expansa** (*Moniezia expansa* Rud.).—Length variable—from some decimetres to 4, 5, and 6 metres, and even more than 100 feet, according to Rudolphi. Head generally small—from ·5 mm. to ·8 mm.—slightly expanded; suckers a little salient, oval, opening elongated and turned outwards. Neck very short or *nul*. Anterior part of the strobila filiform. First segments very short; the others, longer, are always broader than they are long, their breadth attaining 16 mm. in the last segments, which are very thick. The ova, cuboid or globular, from 50 to 90 μ in diameter.

2. **Tænia alba** (*Moniezia alba* Perr.).—This species was distinguished from the preceding by Perroncito. It is ·60 metre to 2·50 metres long. Head larger, measuring 1·15 mm. to 1·40 mm. broad; suckers hemispherical, and opening obliquely forwards and outwards. Neck short, but distinct. Segments thicker, longer, and narrower than in *T. expansa*, and sometimes longer than

they are broad, though rarely attaining more than 10 mm. to 12 mm. in breadth. The ova are 48 μ to 58 μ broad.

3. **Tænia planissima** (*Moniezia planissima* Stiles and Hassall).—Length 1 to 2 metres; tint yellowish. Head nearly square, from 0·8 mm. to 0·9 mm. broad; suckers with slightly elongated openings. Segments always broader than long, longer than thick; the ripe segments measure from 12 to 26 mm. broad by 1 mm. to 1·75 mm. long, generally very thin and translucid. Eggs 63 μ in diameter.

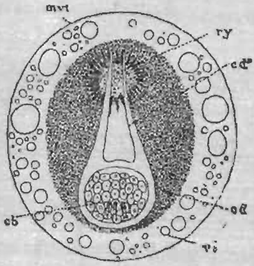

FIG. 185.——Ovum of the *Tænia expansa*, completely developed; magnified about 550 diameters.—Moniez.

eb, hexacanthus embryo; *ed″*, pyriform apparatus formed by the internal delaminated layer; *ed*, external delaminated layer; *ry*, granular mass arising from *ed*, and carried by the horns of the apparatus; *vt*, vitelline vesicles; *mvt*, vitelline membrane.

These three species are easily distinguished from one another: *M. planissima* by the thinness of its ripe segments; *M. expansa* by its very short, broad and thick segments; and *M. alba* by its relatively narrow and long segments. These tæniæ are not confined to cattle. *M. expansa* appears to be more frequent in Sheep than in bovines, and it is also found in the Goat and in some wild ruminants. *M. alba* is common in the Ox in Italy, where it has also been found in the Sheep by Perroncito; Moniez has observed it at Lille, and Railliet at Alfort, in the Ox; while Blaize has sent us several specimens from an Ox in Algeria. *M. planissima* is a parasite of Sheep and cattle.

These Tæniæ inhabit the small intestine, and no trouble in the digestive functions of cattle has been ascribed to them; but Villar has mentioned the case of a Cow in which *T. expansa* appears to have induced serious colic; and Sheep are reported to have suffered from the presence of this worm.

TREMATODES.—Only a single species of Trematode has been found in the intestine of the Ox. This is the *Amphistomum tuberculatum* Cobb., met with in cattle in India along with the Amphistomes of the rumen. There is no occasion to allude to the *Bilharzia*, the ova of which may be found in the substance of the more or less altered intestinal mucous membrane (see *Hæmatozoa*).

NEMATODES.—The **Calf Ascarid** (*Ascaris vitulorum* Gœze) is of a reddish-white colour, and has a transparent integument when in the fresh state. The head is small and distinct, and has the lips enlarged at the base, constricted in their anterior two-thirds, their free margin being markedly denticulated. The posterior extremity is terminated by a kind of conical point. The *male* is 15 cm. to 20 cm. long, exceptionally 26 cm. The caudal papillæ form two irregular rows—very lateral—of 10 to 15 each, all pre-anal. The *female* is 22 cm. to 30 cm. long; the vulva is situated towards the anterior sixth of the body. The ova are 75 μ to 80 μ in diameter.

The *Ascaris vitulorum*, rare in adult animals, is somewhat common in the calf—especially in the South of France. In 1712, Vallisnieri ascribed to this worm an epizoöty among calves in the neighbour-

hood of Padua, to which animals sometimes succumbed; their flesh, it appears, acquired a very bad odour. The parasite is very frequently seen in calves killed for veal in Toulouse, and sometimes it is counted by hundreds and even thousands, in the intestine, being also met with occasionally in the abomasum. Local inflammations of the intestinal mucous membrane are noted in these cases, and they may give rise during life to colic, and exceptionally to rupture of the organ. Descomps has reported an

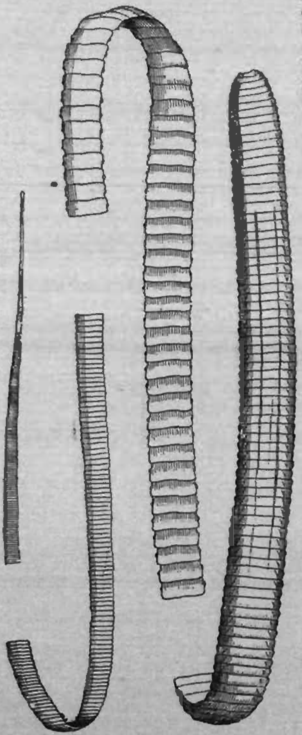

FIG. 186.—*Tænia expansa*; natural size.—Railliet.

FIG. 187.—Cephalic extremity of *Tænia expansa*; magnified forty diameters.

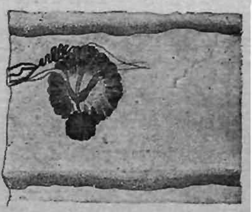

FIG. 188.—Lateral third of a segment of *Moniezia planissima*, showing the arrangement of a genital spot; magnified fifteen diameters.

instance of this accident, in which the intestine contained 15 litres of Ascarides.

To expel the Ascarides of the calf, Guittard recommends the administration in the evening after feeding, of 8 to 12 grammes of rectified empyreumatic oil in a mucilaginous emulsion, and next morning a purgative of sulphate of soda. The worms will be expelled in bundles in the course of the day.

FIG. 189. — Cephalic extremity of *Tænia alba*; magnified twenty diameters.

Strongylus ventricosus (Rud.).—Body filiform. Head small and slightly winged; no buccal papillæ. Integument streaked by 14 longitudinal ridges, five of the largest being on each of the surfaces dorsal and ventral, and two smaller on each side. *Male* 6 mm. to 8 mm. long; caudal pouch broad, and obscurely trilobate. *Female* 11 mm. to 12 mm. long; vulva situated behind the middle of the body, and surrounded by a cutaneous enlargement, from which is derived the specific name. This worm inhabits the small intestine of Cattle and the European Deer. No morbid influence is attributed to it. In consequence of its smallness, it often escapes notice.

Œsophagostomum inflatum (Sch.).—Mouth circular, with a prominent rim having six papillæ. Anterior extremity provided with an ample trans-

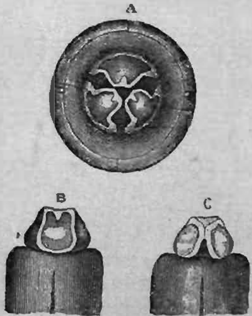

FIG. 190.—Anterior extremity of the Ascarid of the Calf.

A, seen in front; magnified twenty diameters. B, dorsal view, and C, lateral view; magnified thirteen diameters.

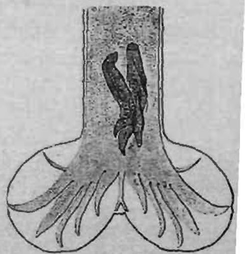

FIG. 191.—Caudal extremity of the male *Strongylus ventricosus*; magnified 150 diameters.—Railliet (inedited).

parent cutaneous enlargement, immediately followed by two lateral membraneous wings, which are traversed by two papillæ. *Male*, 14 mm. to 15 mm long, with caudal pouch faintly trilobate. *Female*, 16 mm. to 20 mm. long

vulva situated a little in front of the anus, and surrounded by a ring (Railliet). This species, which inhabits the large intestine of the Ox, has been removed from the genus *Strongylus*, and placed in the genus *Œsophagostomum* by Railliet.

Anchylostomum radiatum (Rud.).—Was found by Rudolphi in the duodenum of a calf. The *male* measures about 15 mm., and the *female* 25 mm.

Trichocephalus affinis (Rud.).—So called by reason of its resemblance to the Trichocephalus of Man (*Tr. dispar* Rud.—Fig. 162), this species has the head sometimes furnished with two transparent vesicular enlargements in the form of wings. The marginal papillæ of the longitudinal band are larger than the others. The male and female measure, each, 6 cm. to 8 cm. long. The spicule of the male is very long, and its sheath, which is very long also, is studded with triangular spines, the points of which are posterior (Fig. 193).

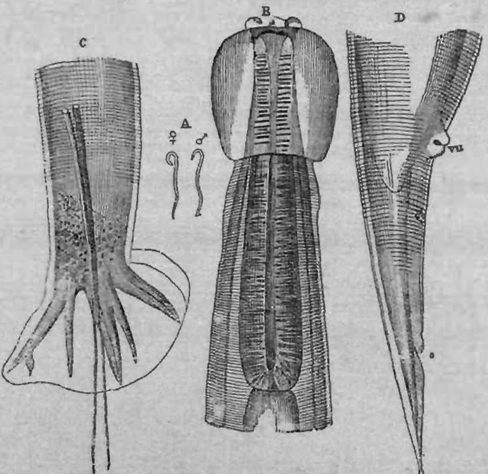

FIG. 192.—*Œsophagostomum inflatum.*

A, male and female, natural size. B, anterior extremity. C, caudal extremity of the male. D, caudal extremity of the female: *a*, anus; *vu*, vulva; magnified one hundred diameters.—Railliet.

The *Trichocephalus affinis* inhabits the large intestine—and particularly the cæcum—of bovines; but it is more rare in the Ox than in the Goat, and especially the Sheep. In general, it attaches itself very firmly to the mucous membrane; but it causes no trouble. Leuckart has remarked that the ova of this species, when kept in a damp place, develop their embryos in a variable period, according to the season; but it may be several months in cold weather.

When these ova are swallowed by Sheep, they are transformed into young parasites, which are adults in about sixteen days. The investigations of Grassi have placed beyond doubt the fact, that this development does not require an intermediate host.

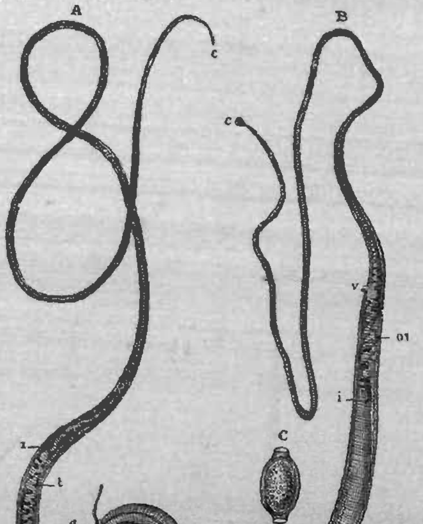

FIG. 193.—*Trichocephalus affinis*; largely magnified specimens.—Delafond

A, male; B, female: *c*, cephalic extremity; *i*, intestine; *a*, anus; *t*, testic *vs*, seminal vesicle; *g*, sheath of the spicule; *ov*, ovary; *v*, vulva; C, ovu magnified 200 diameters.

Other Nematodes.—Von Linstow again mentions—no doubt following Le —the *Filaria papillosa* Rud., and *Trichina spiralis* Owen, as being found the intestine of Bovines; but there is certainly an error with regard to first parasite, and the second could only be found after infestation experim on cattle with trichinous flesh.

Dreschler has found beneath the intact mucous membrane of the intes

of an Ox—the other organs of which were healthy—about 450 nodules the size of a pin's head to that of a pea, the majority of which had undergone caseous degeneration. Spherical in shape and well defined, they were composed of strong fibrous tissue, and each contained an undetermined Nematode or, rather, a larva—about 1 mm. long, which had two conical cephalic papillæ. These were probably the larvæ of a Strongylus.

ARTICLE III.—Parasites of the Intestine of the Sheep.

FUNGI.—The *Saccharomyces guttulatus* Robin has been found by Remak in the intestinal mucus of the Sheep, as in the Ox.

INFUSORIA.—Grassi has discovered in the intestine of the Sheep the *Lamblia intestinalis* (Blanchard) which has been very often seen in Man, and which is very common in the Muridæ—Rats, Mice, Meadow-Mice.

COCCIDIA.—First noted by Rivolta (1874), by Leuckart, then by C. Curtice and by McFadyean, intestinal Coccidiosis of the Sheep has been well studied by Moussu and Marotel, and it would appear that these various observations refer to the same parasite *Coccidium Faurei* (Moussu and Marotel). The lesions are variable. Sometimes they take the form of scarcely prominent whitish spots formed by enlarged villi of which the epithelial cells are hypertrophied, and contain one or several coccidia from 18 to 21 μ long by 15 to 16 μ broad (Curtice, Stiles).

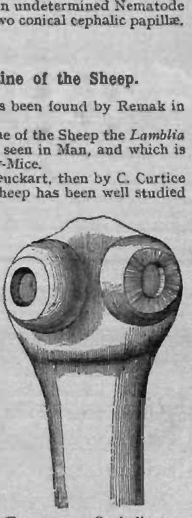

FIG. 194.—Cephalic extremity of *Moniezia Benedeni*, magnified forty-five diameters.

Sometimes there are found pear-shaped, reddish, tumour-like bodies, two or three times larger than an oat grain, and produced by an irregular hyperplasia of the mucous membrane including both the villi and the glandular stratum; the epithelial cells enclose coccidia of various ages, which, when mature, measure 20 μ long by 14 μ broad (McFadyean).

In the contents of the inflamed intestine Mazzanti has found coccidia from 30 to 50 μ long by 14 to 28 μ broad.

In the observations of Moussu and Marotel the largest coccidia of the intestinal contents were 42 μ long by 30 μ broad. In an ovine coccidiosis, Nocard found on the surface of the mucosa of the small intestine some nodules from the size of a pea to that of a nut due to an hypertrophy of the mucosa; the epithelial cells of the villi and of the glandular *culs-de-sac* contained coccidia from 10 to 12 μ long by 7 to 9 μ broad, probably different from *Coccidium Faurei*, notwithstanding the analogy between the lesions of this coccidiosis and that which McFadyean has observed.

CESTODES.—The Sheep is—after the Dog—the domesticated animal which most frequently harbours cestodes. Twelve distinct species, all unknown in their cystic form, have been described. Of these one, *Tænia Vogti* (Moniez), which is only known by a headless fragment, need not be further mentioned. The eleven other species belong to the anoplocephaliens sub-family of the Tæniadæ, and are characterized by the head being destitute of rostrum and hooks, segments compact, broader than long, a transverse uterus and an embryo furnished with a pyriform apparatus. The anoplocephalinæ of the Sheep belong to three genera: *Moniezia* R. Bl., *Thysanosomum* Dies., and *Stilesia* Raill.

A. **Moniezia.**—Genital pores double, uterus double. 1. *M.* (*Tænia*) *expansa*. 2. *M.* (*Tænia*) *planissima*, and 3. *M.* (*Tænia*) *alba* are the same species as those met with in the intestine of the Ox. 4. *M. trigonophora*

(Stiles and Hassall) is allied to the preceding species. 5. *M. Benedeni* (Moniez) is difficult to distinguish from other species of *Moniezia*. 6. *M. Neumanni* (Moniez) does not exceed 50 to 70 cm.; the anterior extremity of the chain is very slender, filiform; the broadest segments are only 8 mm. by 1·5 mm.

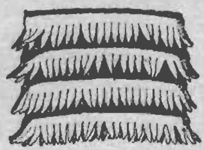

FIG. 195.—Segments of the anterior region of the *Thysanosomum actinioides*; magnified ten diameters. Railliet (inedited).

FIG. 196.—Lateral portion of the last segments of the *Th. actinioides*; magnified ten diameters.—Railliet (inedited).

long. 7. *M. Nullicollis* (Moniez) is about 40 cm. long, has segments immedi ately behind the suckers; the broadest segments are 8 mm. by 1 mm. long.

B. **Thysanosomum.**—Genital pores double or irregularly alternate; uteru single, transverse, with oviferous sacs in the form of asci.

8. *Th. actinioides* (Diesing) genital pores double, segments cut into lon

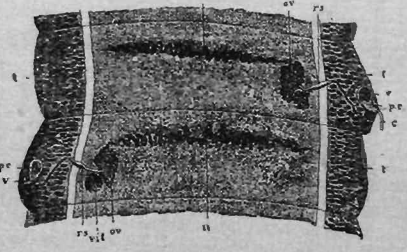

FIG. 197.—Two segments of *Thysanosomum Giardi*; magnified twenty diameters.—Rivolta.

t, testicles; *pc*, pouch of the cirrus; *c*, cirrus; *v*, vagina; *rs*, seminal reservoir; *u*, trace of the uterus; *vit*, vitellogens.

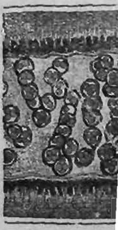

FIG. 198.—T verse section segment of th *Giardi*, sh the arrangem the ovigerous sules; mag forty diamet

fringes at their posterior border. 9. *Th. Giardi* (Moniez) Genital pores irre larly alternate, some times double; segments not fringed; length 2 me and more.

C. **Stilesia.**—Body narrow (2 to 4 mm. broad); genital pores irregul alternate; transverse uterus, without oviferous sacs.

10. *St. globipunctata* (Rivolta).—A very delicate diaphanous worm, 45 to 60 cm. long. Head ·5 mm. to 1 mm. broad; suckers directed forw

No neck. The mature segments are 2 mm. broad, and $\frac{1}{8}$ to $\frac{1}{7}$ millimètre long. Testicles lateral, and external to the longitudinal canals. Genital pores single in each segment, and irregularly alternated. Each segment has a double uterus, which appears to the naked eye or hand-lens as two longitudinal series of opaque points, doubled outwardly—in the anterior part of the strobila—by the spermiducts, the middle line of the strobila remaining transparent. Ova globular, from 15 μ to 21 μ in diameter, and a pyriform apparatus without horns.

11. *St. centripunctata* (Rivolta).—Head from 1·5 mm. to 2 mm. broad. Length of strobila 2·75 to 2·85 metres. The head is succeeded by a narrower portion, in which the segments are faintly marked by fine transverse striations. At a decimètre from the head—where their width varies from 2 mm. to 4 mm.—the segments are remarkable for their relative dimensions, being the more narrow and thick as they are posterior—the last are scarcely more than 1 mm. broad, but they are very thick. Their length is always inconsiderable, but increases from before to behind—varying from $\frac{1}{16}$ to $\frac{1}{5}$ of a millimètre. The genital pores are single in each segment and irregularly alternated; they are little apparent, and open in the middle of one of the sides. The testicles are symmetrical, and situated within the longitudinal canals. In the centre of each segment in the posterior moiety of the strobila, the naked eye can detect a slightly prominent white spot formed by the uterus. Ova few in number in each segment, globular, from 21 μ to 24 μ in diameter, and a pyriform apparatus destitute of horns.

The twelve species of tæniadæ of the Sheep are easily distinguished by referring to the following table:

Posterior border of segments not fringed.	Two genital pores in each segment.	A neck.	Suckers in the form of a slit.	Last segments very thick, all broader than long, may attain 16 mm. in breadth - - - -	*M. expansa.*
				Last segments short, thin, translucent, from 16 to 22 mm. broad - - - -	*M. planissima.*
				Last segments very thick, nearly as long as broad, 16 mm. in breadth -	*M. trigonophora.*
			Suckers globular with a round opening.	Neck short, segments thick, 10 to 12 mm. broad - - -	*M. alba.*
				Neck nearly as broad as the head, last segments 12 mm. broad - - - -	*M. Benedeni.*
				Anterior part of the chain filiform, ripe segments 16 mm. broad - - - -	*M. Neumanni.*
		No neck - - - - - - - - - - - - - -			*M. nullicollis.*
	One genital pore in each segment.	Ripe segments longer than broad			*T. Vogti.*
		segments always broader than long.	Ripe segments 5 to 10 mm. broad - - - - - - - - -		*Th. Giardi.*
			Ripe segments 1 to 2 mm. broad.	Transparent in the middle line - - -	*St. globipunctata.*
				Opaque in the middle line -	*St. centripunctata.*
Posterior border of segments fringed - - - - - -					*Th. actinioides.*

These various Tæniæ are far from having the same importance. Thus, Moniez has only seen one *T. Vogti*; and Rivolta has only once met with his *T. ovilla* (*Th. Giardi*), of which Perroncito has received two examples (*T. aculeata*). It is true that, according to Moniez, this species (*T. Giardi*) is somewhat common at Lille, but it is not believed to cause any harm to the Sheep.

Four *St. centripunctata* were found by Rivolta in the small intestine of an anæmic Sheep. At the point they occupied, the mucous membrane was partly red in consequence of the hyperæmia of the villi, and partly pale or greyish, because of their pigmentary degeneration. Matozzi has met with the same species, but he only noted catarrh of the mucous membrane. Blaise, who has sent us several examples from Algeria, does not make any remark as to lesions.

With regard to the *St. globipunctata*, those which Rivolta has described under the name of *T. ovipunctata* had their head deeply buried in the intestinal mucous membrane. Their presence had brought about degeneration in a large number of villi, irritation of Lieberkühn's glands, and the formation of isolated or confluent inflammatory nodules, from the size of a pea to that of a lentil.

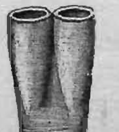

FIG. 199.—Cephalic extremity of the *Stilesia centripunctata*; magnified ten diameters.

The other species are broader and more voluminous, and have a more important pathological *rôle*.

The *Th. actinioides*—first found by Natterer in various kinds of South American Deer—is very abundant in sheep in the western plains of the United States. Its presence induces a tæniasis little characteristic—being simply a pernicious anæmia, the same as is so often observed in flocks of Sheep. It has great analogies with that attributed, in Europe, to *M. expansa*, and in the etiology of which other species—at least *M. alba*, and doubtless also *M. Benedeni* (which appears to us to be very frequent)—may have a large share.

When these tæniæ (*expansa*) are not numerous, they do not produce any appreciable disorder in the digestive functions. But it is otherwise in some instances—rare in France, but more frequent in Germany—in which, by their number and by their length, these worms cause a serious epizoötic among the lambs and year-old Sheep—the disease being known to the Germans as the *Bandwurmseuche*.

The disease at first is obscure. There is paleness of the skin and visible mucous membranes, the fleece is brittle and poor in fine wool; then follow emaciation and arrested development, although the animals eat and drink more than usual. Soon various disturbances in the digestive functions are manifested, rumination is irregular, breath unpleasant and nauseous, colic, constipation, and distension of the abdomen—either because of the retention of the accumulated fæcal matters, which can be felt on pressing the

abdominal walls, or by the gas that inflates the intestine. When the defecatory efforts are successful, the fæces are noticed to be soft, mixed with a yellowish mucus, and there are often some segments of *M. expansa*. The Sheep become more and more emaciated and feeble; they can scarcely move, and follow the flock with great difficulty. They are at times seized with convulsions, and at last colliquative diarrhœa brings them to the final stage of debility and cachexia, in which—unable to rise—they lie stretched on the ground, and quickly perish from exhaustion.

Many outbreaks of fatal diarrhœa due to *M. expansa* are on record. In 1855, Cox described one; in 1877, an enzoöty occurred in Central Park, New York, in which the intestines of lambs were filled with Tæniæ fifteen feet long, which would fill a twelve-ounce glass measure. The animals were for two or three days unwell; they then became affected with convulsions, would turn round in a circle, and drop dead. Cross, of Shrewsbury, in 1877, dealt with 'scouring' in lambs, in the semi-fluid fæces of which were innumerable segments with double sexual organs and unarmed heads. Cobbold mentions being consulted concerning loss from worms of 1,200 out of 8,000 Sheep, on a farm to the north-west of Sydney, New South Wales. Tæniæ several fathoms in length were said to have been discovered in the intestines, together with certain Nematodes. And Gamgee mentions that in Australia, especially on overstocked land, Tæniæ infest lambs, and give rise to an enzoöty that kills many. The tapeworm segments may often be seen on the washed soil, after a heavy fall of rain. The parasites cause pain and emaciation, and predispose the animals to other disorders. They cause loss not only by fatalities, but by reduction in value and amount of fat. Curtice observed young and adult Tapeworms in immense numbers, in 87 per cent. of Western Sheep and lambs examined in Colorado, United States of America, in 1887. The Sheep were diseased in direct relation to the prevalence of the parasites, which he thought were new, and similar in species to that found in the Brazilian Deer; but which were probably *M. expansa*. The outbreak prevailed from Oregon and Wyoming to Nebraska and Kansas, the parasites being present from May to January chiefly in the duodenum.

The diagnosis, embarrassing at first, is decided by the appearance, of the proglottides thrown out along with the fæces. In any case, if there is difficulty in deciding as to the nature of the malady, the doubt can be dispelled by killing a sick lamb and examining it, when numerous Tæniæ will be found obstructing the intestine. The other animals can then be treated with certainty.

Although this tæniasis may manifest itself among Sheep kept in the fold, yet it is most prevalent among the young animals grazing, and it is quite probable that they take up the *M. expansa* in its cystic or larval form, with the grass when at pasture. The disease, in fact, shows itself in wet years, and in damp, marshy regions, conditions favourable to the preservation of the germs of Tæniæ.

Although lambs with the ewe are often affected—and in those of four weeks Spinola has found worms 10 mètres long—yet it cannot be admitted that the germs of the Tæniæ reach them during fœtal life, or through the milk of the ewe, as has been suggested. It is more likely that the young animals infest themselves in picking up, here and there, some stalks of herbage in the pastures, or directly in some other way not yet ascertained.

It is obvious that flocks should be kept away from suspected pastures. When practicable, infested pastures should be ploughed up, or top-dressed with sodium chloride, sodium nitrate, lime, gas lime, or any other substance likely to destroy the germs at a period when these are on the ground, and the fæces, with ova and worms, should be destroyed by burning or other means.

Treatment is only likely to be of avail before cachexia has set in. Each animal should receive a teaspoonful of Chabert's empyreumatic oil (oil 1 part, oil of turpentine 3 parts), with 25 to 35 centigrammes of tartar emetic; later, every day there should be given 15 grammes of tansy-root for six or seven days. Zürn recommends picrate of potash in doses of ·6 to 1·25 grammes in pill every day, a purgative being given afterwards.

The comparative experiments of Hartmann show that kamala is an excellent tænifuge for the Sheep. He prescribes a dose of 3·50 grammes, suspended in water, and repeated once at four hours' interval. Philippi has made trial of picrate of potash, areca-nut, the ethereal extract of male shield-fern, and kamala, and gives preference to the two latter remedies. He administered the first (male fern) in 3 and 4 gramme doses, and the second (kamala) in 5 and 6 gramme doses, giving a dose of castor-oil three hours afterwards. Mojkowski considers naphthalin superior to kamala as a tænifuge; he gives it in 1 gramme doses twice a day for a week, terminating the treatment with a sulphate of soda purge.

NEMATODES.—**Ascarid of the Sheep** (*Ascaris ovis* M. C. V.).* This is yellowish-white in colour, and somewhat attenuated at both extremities. The head is small; each lip has finely denticulated borders, the superior lip having two papillæ, and each of the others only one. The *male* measures 7 cm. to 10 cm. long, and 2 mm. thick; its caudal extremity has—on the ventral surface—two rows of 45 to 50 papillæ each, three of which are post-anal, and one single at the very end of the body. The *female* is 7 cm. to 12 cm. long, and of the same thickness as the male; the vulva opens towards the anterior third of the body.

This species was only known by one female specimen seen in the Vienna Museum by Diesing, and already mentioned by Rudolphi in 1819, until we gave a description of it. It is therefore very rare. R. von Drasche considers as belonging to a different species two females found in a Sheep by Köbl, but in a bad state of preservation.

Strongylus filicollis (Rud.).—A white or rose-white filiform worm. The integument is marked by eighteen longitudinal ridges. Head very small, and margined by two little membraneous wings. *Male*, 8 mm. to 15 mm. long, with bilobate caudal pouch. *Female*, 16 mm. to 24 mm. long, with the anterior portion very thin, and its posterior part short and somewhat expanded (hence the specific name); vulva situated behind the middle of the body.

* Museum Cæsareum Vindebonense—Imperial Museum of Vienna.

The *Strongylus filicollis* inhabits the small intestine, particularly the duodenum of the Sheep and Goat. Railliet has found it in the abomasum of the Sheep, in company with the *Strongylus contortus*, with which it appeared to play the same part. The small intestine may contain myriads of this parasite, as Railliet, and probably Chédhomme, has remarked. By its presence it may set up irritation in the mucous membrane, and by the blood it abstracts will induce pernicious anæmia. Curtice says it is frequent in autumn and winter in the United States of America; but it does not appear to be blamed for any serious damage.

Wedl has described, under the name of *Trichosomum papillosum*, a Nematode that he has found in considerable numbers in the intestine of a Sheep; but Curtice remarks that it was probably a young *Strongylus filicollis*.

Strongylus ventricosus (Rud.).—This parasite of the Ox's intestine has also been found in that of the Sheep by Curtice.

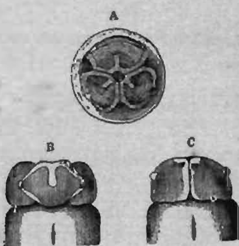

FIG. 200.—Anterior extremity of the Ascarid of the Sheep; magnified thirty diameters.

A, anterior surface; B, dorsal surface; C, ventral surface.

Œsophagostomum venulosum (Rud.).—Mouth circular, and surrounded by a raised ring that has six papillæ. The neck is marked by an ovoïd enlargement; and a little behind this are two lateral papillæ, and behind these, again, is the commencement of two membraneous wings. *Male*, 15 mm. to 16 mm. long; caudal pouch slightly trilobate, and broader than it is long. *Female*, 23 mm. to 24 mm., vulva situated a little in front of the anus. This Nematode has been more especially found in the Goat, in which it is rare. Railliet discovered it in the Sheep, Chabin (long-woolled Sheep of Berry, France), and Roe-deer, and he considers as belonging to the same species two female Nematodes which Carita found in the intestine of a Sheep, along with *Sclerostomum hypostomum* and *Anchylostomum cernuum*.

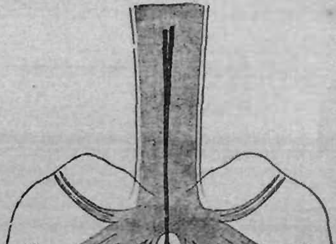

FIG. 201.—Caudal extremity of the male *Strongylus filicollis*; magnified 150 diameters.

Œsophagostome of Columbia (*Œs. Columbianum* Curtice). — Body a little attenuated from before to behind. Mouth circular, sustained by a horny ring, armed with two crowns of teeth—of which the internal are the smallest—and surrounded by a cutaneous ring on which are six pointed papillæ. This ring is succeeded by a slight elongated constriction,

terminated by another ring at the ventral transverse slit. Towards the anterior fourth of the œsophagus are two opposed papillæ, and at the anterior quarter of the body are two narrow wings on each side. *Male*, 12 mm. to 15 mm. long; caudal pouch slightly sinuous and shallow, with its ribs arranged as in *Œsophagostomum dentatum* (Fig. 210). *Female*, 14 mm. to

FIG. 202.—Cephalic extremity of the *Strongylus contortus*; magnified forty diameters.—Railliet (inedited).

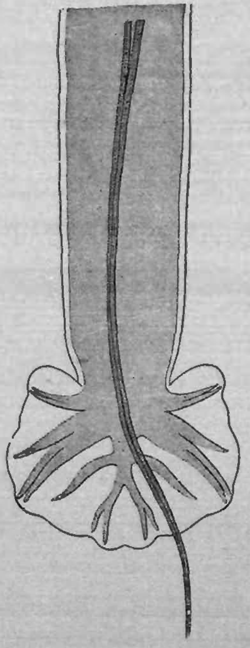

FIG. 203.—Caudal extremity of the male *Œsophagostomum venulosum*; magnified one hundred diameters.—Railliet (inedited).

18 mm. long; vulva situated a little in front of the anus. Eggs ovoïd, and 90 μ long by 50 μ broad.

This species—which is closely related to the *Œs. dentatum* of the Pig—is, according to Curtice, frequent in adult Sheep in the Southern United States, and is more particularly observed in the autumn and winter; it does not cause

any trouble except when in great numbers. The symptoms have nothing characteristic, and are those of insidious anæmia slowly leading to marasmus. This Œsophagostome is found in the adult state in the cæcum and first portions of the large colon. But it appears more frequently in the larval condition—3 mm. to 4 mm. long, and lodged beneath the mucous membrane in tumours varying in size from that of the head of a pin to that of a hazel-nut, each of them containing only one worm. The mucous membrane is sometimes so studded with these tumours that great inconvenience is experienced in preparing the intestine for sausage-making.

Sclerostomum hypostomum (Duj.).—Body white, filiform, cylindrical, and rigid. Head globular, slightly curved and obliquely truncated towards the ventral surface; mouth furnished with a double row of narrow, sharp teeth, and surrounded by six papillæ. *Male*, 10 mm. to 20 mm. long; caudal pouch short, obliquely cut, and campanuliform. *Female*, 13 mm. to 23 mm. long; tail often encrusted with a dark yellow substance, and terminating in a sharp point curving upwards; vulva situated a little in front of the anus. This worm is common in the large intestine of the Sheep and Goat. Carita accuses it—as well as the next species—of causing fatal anæmia in a Sheep, the intestinal mucous membrane of which was covered with red punctures. Friedberger and Fröhner also state that the *Sclerostomum hypostomum* may induce slight colic, and that at the autopsy they have seen the small intestine strewn with minute punctiform hæmorrhages, the intestinal contents being the colour of chocolate. According to the observations of Railliet, the ova undergo, externally, modifications very similar to those which have been indicated for the Sclerostomes of the Equidæ. There is, therefore, reason to believe that the *Scl. hypostomum* is also ingested as an embryo, in the water drunk by Sheep and Goats.

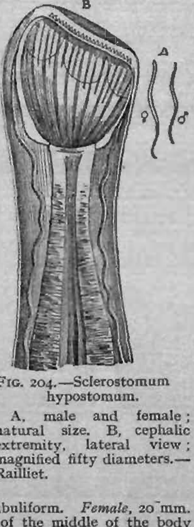

FIG. 204.—Sclerostomum hypostomum.

A, male and female; natural size. B, cephalic extremity, lateral view; magnified fifty diameters.—Railliet.

Anchylostomum cernuum (Crep.).—Body yellowish or reddish, rigid, and attenuated at the extremities. Head thin and raised behind. Mouth circular and opening into an ovoïd buccal capsule armed with four teeth—two on each side, the base of which is imbedded in the capsule, and the free extremity is curved hook-like towards the interior of the cavity; the two ventral teeth are strong, the dorsal ones narrow; the dorsal rib also buries its conical point in the capsule; lastly, the armature is completed by the two deep ventral lancets. *Male*, 15 mm. to 18 mm. long; caudal pouch deep and infundibuliform. *Female*, 20 mm. to 28 mm. long; vulva placed a little in front of the middle of the body (Railliet). This species lives in the small intestine, and sometimes in the large intestine, of the Sheep and Goat.

Trichocephalus affinis.—This parasite has been already described (p. 353) among the entozoa of the Ox, in which it is more rare than in the Sheep. Its pathological effects are unknown, and probably they are insignificant; though Simonds states that when a number of Sheep suffer at the same time from diarrhœa with much mucus, and their appetite is increased, the disease is generally due to this worm.

Strongyloides longus (Grassi and Segre).—Grassi has discovered in the intestine of a Sheep, a species of Angiostome nearly identical with the in-

testinal Angiostome of Man (see p. 328), but of larger size. The *female* measures 6 mm. long. The body is a little attenuated in front, and terminates behind by a round conical tail, which may be even a little dilated at its extremity. The triangular mouth has three small lips, and opens into an almost cylindrical, long œsophagus, which is continued by the intestine without marked transition. The vulva is situated in the posterior third of the body.

This species may have—like that of Man—a free generation, if the larvæ are kept at a temperature above 25° (Cent.). But while among the worms which have reached maturity there are—with the *strongyloides intestinalis*—about one male to eight females, nearly all here are females, which rarely show ova in process of segmentation, and larvæ resulting from free generation have not yet been seen. In addition, the mature strongyloid of the Sheep is much smaller than that of Man. The chief difference between the two species

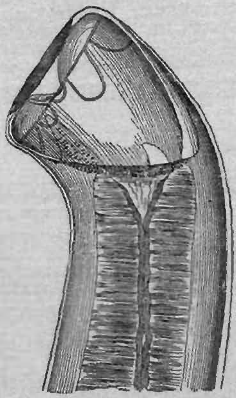

FIG. 205.—Anterior extremity of *Anchylostomum cernuum*, lateral view; magnified 150 diameters.—Railliet.

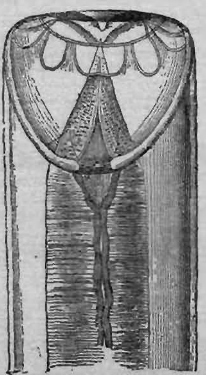

FIG. 206.—Anterior extremity of *Anchylostomum cernuum*, dorsal view; magnified 150 diameters.—Railliet.

is that, in the *strongyloides intestinalis*, the intestinal form is derived indifferently either from the larvæ of the Angiostome transformed external to the human body, or from larvæ emanating from a free generation; while in the *Strongyloides longus* this second mode of reproduction is doubtful, or at least very rare. This latter species causes no particular trouble in Sheep.

ARTICLE IV.—Parasites of the Intestine of the Goat.

CESTODES.—Rudolphi gave the provisional name of *Tænia capræ* to fragments of tape-worms without a head which had been found in the ileum of a Goat. It is probably one of the species of *Moniezia* which live in the intestine of the Sheep. Apart from this exceptional instance, all the Tæniæ met with in the Goat have been classed with *M. expansa*, which has already been described among those of the Ox and Sheep. In some exceptional cases, this

worm may, by its accumulation, cause accidents similar to those we have seen it produce in the Sheep. The same remarks and treatment will therefore apply to it.

NEMATODES.—Five species of Nematoda have been noted in the intestine of the Goat; they have also been seen in the Sheep, and are: *Strongylus filicollis, Œsophagostomum venulosum, Sclerostomum hypostomum, Anchylostomum cernuum,* and *Trichocephalus affinis.* There is nothing to add to what has been said about these parasites in the Sheep.

ARTICLE V.—Parasites of the Intestine of the Pig.

The Pig affords asylum to a large number of intestinal parasites—a circumstance readily explained by the diversity and frequent impurity of its food. But it offers the remarkable and inexplicable peculiarity that, up to the present time, no adult form of Cestode has been discovered in it.

Tardieu has, however, observed in a Pig symptoms of epilepsy which disappeared on the adoption of anthelmintic treatment. The animal passed 'a considerable quantity of worms, which appeared in pellets at the anus, and amongst them,' says that authority, 'I recognised portions of the solitary worm (tænia), which I suspected to be the principal cause of the disease.'

The majority of the intestinal parasites of the Pig are Nematodes, though it is possible there may also be present Distomes—*Distomum hepaticum* and *D. lanceolatum*—which have escaped from the bile ducts into the digestive canal.

PROTOZOA.—Independently of a Trichomonas that Künstler has met with in the intestine of the Pig, there is very often found in the rectum of this animal a ciliated Infusorian of the order of Heterotricha—the **Balantidium coli** (Stein).

COCCIDIA.—Rivolta attaches to *Coccidium Zurni* the coccidia found by Zurn in the intestine of a young Pig which had succumbed to an enteritis, and which had come from a farm where many other pigs had died at short intervals (Railliet).

ACANTHOCEPHALA.—The Pig and wild Boar are the natural hosts of the best known species of this order—the **Echinorhynchus gigas** (Gœze)—which is also found in the collared Pecari (*Dicotyles torquatus* or Tajaçu) and striped Hyæna.

The giant Echinorhynchus is a cylindroïd worm, often expanded at several points in its length, of a milky-white tint, sometimes shaded with green or violet, irregularly wrinkled transversely, and attenuated behind. The anterior extremity consists of an almost globular proboscis, garnished with five or six transverse rows of hooks curved backwards, and irregularly arranged in quincunx (like a chess-board). The *male* is 6 cm. to 9 cm. long, and 3 mm. to 5 mm. broad; it has a campanuliform caudal pouch. The *female* is 20 cm. to 35 cm. long, and the posterior part of the body is obtuse. The ova are oblong, almost cylindrical, and provided with three envelopes, in which the embryo appears several days after the eggs have been laid. It has the shape of a truncated cone, and being longer than the egg, its tapering extremity is folded up in the shell; the anterior part has four hooks similar to those of the armed Tæniæ, and several other smaller ones.

In the adult state, this worm infests the small intestine, and particularly the duodenum—rarely the large intestine. It is found floating in the fluid contents of the canal, or more frequently it is fixed to the mucous membrane by its proboscis, the anterior part being turned towards the stomach.

Its presence causes a variable degree of irritation at the points where it attaches itself. It may bury itself more or less deeply in the mucous membrane, penetrating as far as the muscular, and even the serous, coat, or entirely perforating the wall of the intestine and opening the peritoneal sac, thereby setting up fatal peritonitis. Most frequently, however, the lesions are limited to a number of small tumefied wounds, the size of a pin's head ; or there are salient cicatrices, which would indicate that the worm often changes its hold.

According to Kocoureck, the intestine which harbours the Echinorhynchus looks pearly white externally, but its walls contain

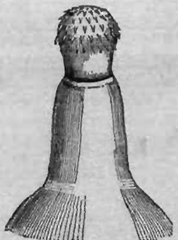

FIG. 207.—Cephalic extremity of the Giant Echinorhynchus ; magnified ten diameters.—Railliet.

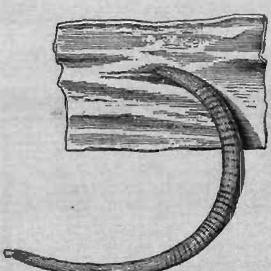

FIG. 208. — Giant Echinorhynchus, male, fixed to the intestine of the Pig ; natural size.—Railliet.

abscesses the size of a hempseed, encircled by a red areola, in the centre of which is the proboscis of the Worm. At other points the mucous membrane is of a slate-grey colour, thickened, and covered with exudate. The more or less complete perforations in the wall of the intestine are often so numerous as to render them useless in the manufacture of sausages.

When the worms are numerous in the intestine, they cause marked disturbance in nutrition. Friedberger and Fröhner give the following symptoms : ' Loss of appetite, constipation, restlessness ; the animals paw and burrow, and apply the snout or teeth against the abdomen ; emaciation increases ; there are convulsions and epileptiform spasms ; with young Pigs death may ensue in three or four days. Frequently the malady assumes an epizoötic form. A diagnostic element might be found in a microscopical

examination of the fæces, which should show the ova of the worm, in which the embryo is not yet present.

The giant Echinorhynchus is common in France and Germany; according to Dujardin, it has been found in Vienna in about one of every four Pigs. Cloquet says that the Limousin Pigs killed in Paris are more affected than those of the other provinces Kœhler asserts that these worms are now much more rare than formerly. Wyman and Leidy have found them in Hogs in the United States of America. According to Cloquet, they are more frequent towards the end of winter than at any other time. We have never met with them at Toulouse. Cobbold says that, fortunately, they are not of frequent occurrence in England.

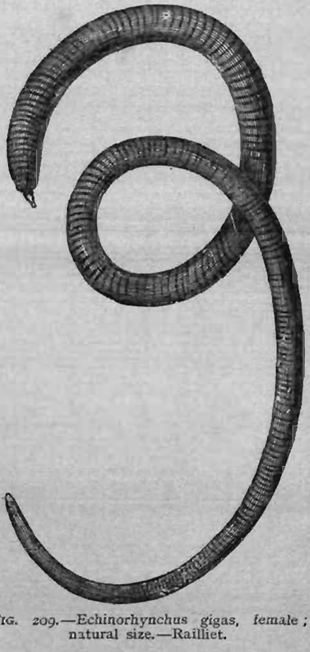

FIG. 209.—Echinorhynchus gigas, female; natural size.—Railliet.

Schneider states that the development of the worm requires an intermediate host, and that this is the *White Worm*—the larva of the ordinary May-bug (*Melolontha vulgaris*). The ova of the intestinal Echinorhynchus are eliminated with the fæces, spread over the ground or carried into the dung-pit, and in these conditions are eaten by the White Worms, and hatched in their intestines; the embryos bore through the walls of these by means of their hooked proboscis, and making their way into the abdominal cavity, become encysted there. In this state they remain during the existence of the larva, and even after its metamorphosis into the perfect insect. If the Pig devours these White Worms, or the May-beetles, the cyst-membrane is dissolved in its intestines, the young Echinorhynchus is set free, attaches itself to the mucous membrane, and gradually acquires its complete develop-

ment. The researches of Lespès had long before revealed the necessity of an intermediate host; he had caused the ova of *Ech. gigas* to be hatched in the intestine of several species of gasteropod molluscs—*Helix pomatia*, *H. hortensis*, *Limax maximus*, *Arion rufus*; and had found a larva in the liver of a helix. What militates against Schneider's opinion, is the fact that the larva of the May-beetle is essentially phytophagous—it lives only on roots, and is not found in manure-pits. Perhaps Kaiser has indicated the real intermediate host; for, according to him, the ovum of the *Ech. gigas* thrown out on the ground with the excrement of the Pig, is swallowed by the larva of the common rose-chafer (*Cetonia aurata*); the embryo then bores through the shell, which has been softened by the gastric juice, passes through the cuticle, and stops at the subjacent muscular layer, where it pursues its evolution (Blanchard).

As there is little information with regard to the pathological effects of the Echinorhynchus, we are still less advanced as to the medicaments to be employed against it; but it would be useful to try experiments with those drugs prescribed for the other entozoa.

It may be mentioned that Leuckart states that *Echinorhynchus gigas* only appears in those swine which have been fed in the open air.

NEMATODES.—The **Ascarid of the Pig** (*Ascaris suis* Gœze—Figs. 119, 122) bears such a close resemblance to the Ascarid of Man (*A. lumbricoides* Linn.—Figs. 157 to 159) that several authorities—Leuckart, Schneider—consider they both belong to the same species, the first being, at most, only a variety.

Like the other, this has a milky-white, or reddish, firm, elastic body; the head is small; the three lips denticulated, the upper having a papilla at each of its inferior angles, the two others only one at the middle of their base. The *male* is 15 cm. to 17 cm. long, and about 3 mm. thick; the caudal end has 68 to 75 papillæ, 7 of which are post-anal. The *female* is 20 cm. to 25 cm. long, and about 5 mm. in diameter; the vulva is situated towards the anterior third, in the middle of an annular constriction. The ova are 66 μ long, with a foveolated shell. According to Dujardin, Walter, and Baillet, this species is distinguished from *A. lumbricoides* by being thinner, the longitudinal striæ closer, spicules less sharp and flatter, longer uterus more doubled, and smaller ova.

This worm infests the small intestine of the Pig, and is not very common; though it is sometimes in sufficiently large number to cause obstruction and colic.

Œsophagostomum dentatum (Rud., *Œs. subulatum* Molin).—Body white or greyish-brown, straight, and attenuated at both extremities. Mouth circular, placed in the centre of a horny ring furnished with a crown of bristles, and surrounded by a transparent cutaneous ridge on which are six sharp papillæ. This circular ridge is succeeded by a constriction, which is followed by an ovoïd cutaneous enlargement—well defined posteriorly—at a slit that occupies the whole breadth of the ventral surface. Two papillæ opposite each other are seen in the posterior quarter of the œsophagus. *Male*, 8 mm. to 12 mm. long; caudal pouch campaniform and rounded, with a small, faintly marked middle lobe. *Female*, 12 mm. to 15 mm. long; caudal extremity subulated; vulva situated a little in front of the anus, and surrounded by a raised ring. This species inhabits the intestine of the Pig, Wild Boar, and white-lipped

Pecari. In the Pig it is most frequently found in the cæcum and colon; Baillet has met with it several times in the small intestine. Little is known of its pathogenic action.

Globocephalus longemucronatus (Mol.).—'*Male*, 7 mm. long; caudal pouch slightly trilobate; posterior ribs tridigitated, middle and anterior ones doubled. Two spicules. *Female*, 8 mm. long; caudal extremity has a conical point ending in an elongated mucrone. Found by Wedl in the small intestine of the Pig' (Railliet).

Trichocephalus crenatus (Rud.).—This species has often been confounded with the Trichocephalus of Man—*Tr. dispar* Rud. But it is more especially distinguished from it by the special features in the sheath of the spicule, which is garnished with short blunt spines, thinly scattered, especially behind, where they disappear; the point of the spicule is rounded. The *male* is 40 mm., and the *female* 45 mm. long. This worm inhabits the large intestine of the Pig. An experiment made by Leuckart shows that—as with the *Tr. affinis*—if the ova of the *Tr. crenatus* containing well-formed embryos are introduced into the digestive canal of the Pig, they are developed directly, and become individuals which have acquired the adult form in about four weeks. It is probable that infestation usually takes place through drinking water. The *Tr. crenatus* does not induce any appreciable derangement in digestion.

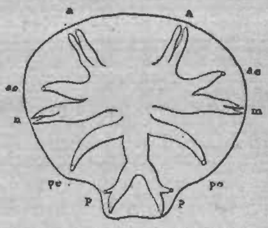

FIG. 210.—Caudal pouch of the *Œsophagostomum dentatum*; magnified ninety-three diameters. — After Schneider.

p, posterior ribs; *pe*, external ribs; *m*, middle ribs; *ae*, antero-external ribs; *a*, anterior ribs.

Trichina spiralis (Owen).—To attain the adult state, this species has to pass through the digestive canal of warm-blooded animals, and of these the Pig is the most important. This parasite will be dealt with in detail when we come to treat of trichinosis, in studying parasitism of the muscles.

Strongyloid of the Pig (*Strongyloides suis* Lutz).—This representative of the family of Angiostomidæ—already observed by Leuckart and Grassi—has been more recently studied—though still in a very incomplete manner—by Lutz. According to him, the Strongyloid of the Pig is a distinct species to that of Man and the Sheep. While the size is different, the ova of the intestinal generation of the Strongyloid of the Pig cannot be hatched except outside—a considerable difference, which should be verified. Otherwise, in localities where the Strongyloid of Man is very common—as in Brazil—Lutz has remarked that this of the Hog is very rare, notwithstanding the chances of infestation to which that animal is exposed, from the absence of latrines, its free life, etc.

Independently of the few details given above with regard to each of the species of intestinal Nematodes of the Pig, it may here be stated, in a general manner, that they have been accused of keeping their host in a state of great emaciation, inducing a violent cough, and a vague restlessness, that betrays itself by the Pig wandering here and there without any apparent motive, as well as by cries, convulsions, etc., symptoms of the colicky pains it experiences.

The Ascarides have been more especially blamed for provoking this morbid condition.

Pigs affected with intestinal helminthiasis are treated with the various medicaments already indicated for the other species, and particularly with decorticated castor-oil seeds. The dose of this for the adult Pig is 8 grammes, mixed with the food, and is most suitable for the Ascarides. Benzine, 10 to 20 grammes, mixed in the food or in pills; or picrate of potash, 20 to 50 centigrammes, given in a mucilaginous decoction or meal and water, are recommended by Zürn against the *Œsophagostomum dentatum*. To expel the giant Echinorhynchus, Kocoureck has obtained good results from the administration of the oil of turpentine—a teaspoonful for a dose; then a purgative of sulphate of magnesia 10 grammes, aloes 5 grammes

ARTICLE VI.—**Parasites of the Intestine of the Dog.**

INFUSORIA.—The *Lamblia intestinalis* Blanch., a Flagellate found by Grassi in the intestine of the Sheep, has also been discovered by him in the intestine of the Dog.

COCCIDIA.—The intestinal Coccidium of the Dog (*Coccidium bigeminum* Stiles) first seen by Virchow and rediscovered by Railliet and Lucet is common in the Dogs of Europe, but it appears to have only an insignificant influence on their health and is met with in healthy dogs, and in those which have died from various diseases.

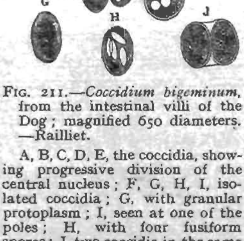

FIG. 211.—*Coccidium bigeminum*, from the intestinal villi of the Dog; magnified 650 diameters. —Railliet.

A, B, C, D, E, the coccidia, showing progressive division of the central nucleus; F, G, H, I, isolated coccidia; G, with granular protoplasm; I, seen at one of the poles; H, with four fusiform spores; J, two coccidia in the same envelope.

The *C. bigeminum* has an ellipsoid shell, slightly asymmetrical, very thin, with a double contour and contents varying according to the phase of development. It is also met with under identical conditions in the Cat (*C. bigeminum var. cati*) and in the Polecat (*C. bigeminum var. putorii*). The *C. bigeminum var. canis* measures 12 μ to 15 μ long by 7 μ to 10 μ broad.

It lives in the interior of the intestinal villi, and not in the epithelial cells. These coccidia are generally arranged two by two, indicating a longitudinal division (Stiles).

CESTODES.—Of all the domesticated animals, the Dog is by far the most frequently infested with intestinal parasites. Of 500 Dogs examined by Krabbe at Copenhagen, 336—or 67 per cent.—had intestinal entozoa. Schöne has also published interesting information as to the frequency and the distribution of Helminthes in the Dog. He has found them in 53 per cent. of sporting Dogs; in 67 per cent. of butchers' Dogs; in 40 per cent.

of watch Dogs; in 72 per cent. of harness Dogs; in 57 per cent. of Sheep Dogs; and in 70 per cent. of pet Dogs. The number of them is sometimes considerable, and they may belong to extremely varied species; but the most frequent are the Tæniæ.

The Dog is, in fact, the favourite host of Tape-worms; for in two-thirds of those which we have examined after death, we found these parasites in more or less considerable numbers—sometimes, indeed, in such quantities as to excite wonder at the persistent good health of the animals. Zürn relates having found 137 Tape-worms in the intestines of a Dog; they belonged to three distinct species, and weighed altogether 375 grammes. The researches of Krabbe prove how frequent these entozoa are in this creature. What is of most interest, is the fact that these Cestodes require an intermediate host in order to effect their evolution, and that for the majority of them this host is one of the domesticated herbivora—Sheep, Ox, Goat, Horse,

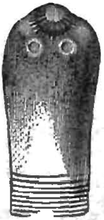

FIG. 212.—Head of *Tænia serrata*, seen three-quarters face, and magnified.

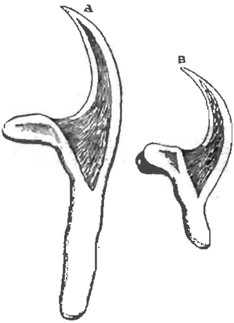

FIG. 213.—Hooks of *Tænia serrata*: magnified 250 diameters.—Railliet. A, large hook. B, small hook.

and Rabbit, or the Pig, or even Man. In their cystic form, and when developing in organs, they sometimes cause very grave maladies, such as 'gid' in Sheep, echinococcosis in the other species or in Man—only to mention the most important. It is this which makes the Dog an obnoxious animal, and one that yields us troublesome compensation for his services. Therefore it is that those administrative measures which are directed towards pleasure Dogs, with a view to limit their number, should be favourably received.

Eight species of Tæniæ, and five or six species of Bothriocephalus of the Dog, have been described. But they are far from having the same frequency and importance, and they may all be found in the intestines of the same animal.

Tæniæ.—Of the eight species of Tæniæ, six belong to the group of Cystotænians (see p. 323); they are: *Tænia serrata* Gœze, *T. mar-*

ginata Batsch, *T. Krabbei* Moniez, *T. cœnurus* Küch., *T. serialis* Baillet, and *T. echinococcus* Siebold. One—*Dipylidium caninum* (L.), *T. cucumerina* Bloch—represents the Dipylidinæ ; and another—the *Mescocestoides lineatus* (Gœze)—is separated from all the other species of the genus by very special characters, with reference to the arrangement of its sexual organs.

The Cystotænians which infest the Dog always have the head provided with a *proboscis* or *rostellum*, which is itself armed with hooks. The latter comprise

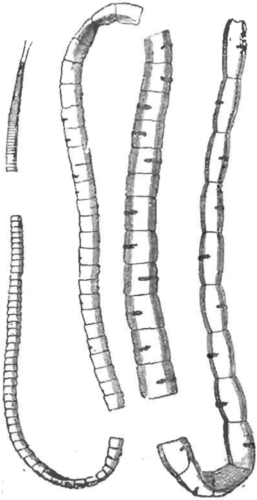

FIG. 214.—*Tænia serrata* ; natural size.

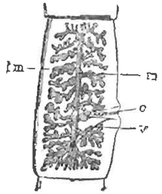

FIG. 215.—A mature segment or joint of *Tænia serrata* ; magnified three diameters.—Railliet.

c, vas deferens or coiled spermiduct ; *v*, vagina ; *m*, body of the uterus ; *bm*, branches of the uterus.

FIG. 216.—Ova of *Tænia serrata*.—Railliet.*

* A, ovum surrounded by the vitelline membrane, and still containing the vitelline masses ; B, ovum freed from its accessory parts.

a free portion or *blade* in the form of a sickle, the convexity being antero-external and the point turned outwards and backwards ; so that when implanted in the intestinal mucous membrane it concurs in fixing the Tænia. This blade is prolonged by a *handle* directed forwards and inwards, and to which are attached the contractile fibres of the rostellum. The point of union of blade and handle is marked on the concave side by an apophysis—*guard, tooth, heel* or *hypomochlion*—that also serves for the insertion of muscular fibres. These hooks are arranged in two crowns or concentric rows, the central area of which is occupied by the summit of the rostellum. They are unequal in size, and are distinguished as *large* and *small* ; these are alternate,

and in this manner form two rows, disposed in such a fashion that the small hooks stand slightly higher than the large ones—the points of both being pretty well on the same circular level. The cephalic expansion is always succeeded by a constricted portion or neck, the first rings—joints or segments—of which only appear at some millimètres from the head.

1. **Tænia serrata** (Gœze).—From ·50 m. to 2 m., but generally 1 mètre long. Head a little broader than the neck; 34 to 38 hooks, the largest of which are from 230 μ to 260 μ, with the handle cylindrical, thick, and longer than the blade—which is short and wide—while the small hooks are 125 μ to 160 μ, and have a short handle with bifid guard. Segments at first narrow and much shorter than they are broad, becoming square or somewhat longer than broad, and showing their genital organs well developed about the 175th segment, or 25 cm. to 30 cm. from the head. Genital pore very prominent, causing the border in which it is placed to be convex, and the proglottis to be wider in its middle than at its ends; posterior border straight and angles salient, which gives the strobila its saw-like appearance; mature segments from 10 mm. to 17 mm. long, and 4 mm. to 6 mm. broad; uterus formed by a longitudinal, median, lengthy trunk, having on each side eight to ten branches, each furnished with numerous irregular ramifications. Eggs ovoïd, 36 μ to 40 μ long, and 31 μ to 36 μ broad.

The cystic form of this worm is the *Cysticercus pisiformis* Zeder, which is frequent in the peritoneal cavity of Hares and domesticated or wild Rabbits. It was with it that Küchenmeister made his first experiments, in which he demonstrated the migrations and metamorphoses of the Tæniæ. The Dog becomes infested with *Tænia serrata* in eating the viscera of Rabbits or Hares containing these Cysticerci. When these have reached the intestine of the Dog, their caudal vesicle contracts and becomes detached; the same occurs with the body. The scolex fixes itself on the mucous membrane, and its posterior part produces—by incessant germination—new segments. Twelve days after their introduction into the digestive canal of the Dog, the Tæniæ are one to three centimètres long, and in about two months their development is so advanced that the last segments are mature and commence to be detached. The ripe ova given to Rabbits become Cysticerci. It is, therefore, by the proglottides that are expelled with the fæces, and the ova which escape from them and are scattered over the grass or carried by water, that the Dog is the cause of the introduction of this parasite into the organism of the Leporidæ.

The *Cysticercus pisiformis*, which becomes the *Tænia serrata*, maintains its vitality for a long time. In the omentum and mesentery of the Rabbit, which have been exposed to the open air—along with the intestine—for more than eight days, there are found Cysticerci that are apparently dead and withered, but which will promptly become reanimated if plunged for a few minutes into water at a temperature of 40° or 50° C. (Baillet).

2. **Tænia marginata** (Batsch., *T. cysticerci tenuicollis* Leuck.).—This is the largest Tænia found in the Dog. It is 1·50 m. to 2 m. long. The head is scarcely wider than the neck. There are 30 to 44 hooks, the larger of which are 180 μ to 220 μ, the handle having undulated, thin borders, and being longer than the blade, which is narrow; the smaller are 110 μ to 160 μ, with an elongated handle curved in the contrary direction to the blade, and have the guard entire. The segments are broader, and relatively shorter, than in

the preceding species, becoming nearly square, and having the genital organs well developed at the 275th to the 300th, or about 50 cm. from the head; genital pore slightly salient; posterior border wavy, or a little crenellated, and received into the succeeding segment. Mature segments 14 mm. to 16 mm. long, and 5 mm. to 7 mm. broad; uterus formed by a short median trunk, having on each side five or six—sometimes eight—branches deeply divided and ramified. Ova almost spherical, and from 31 μ to 36 μ in diameter.

This worm — which is less common than *Tænia serrata*, comes from the *Cysticercus tenuicollis* Rud., which is found in the peritoneal, more rarely in the pleural sac, and even in the pericardium of various animals, and especially in the domesticated Ruminants. The experiments of Baillet show that the development of this Tænia is slower than that of *T. serrata*. Two months after the ingestion of

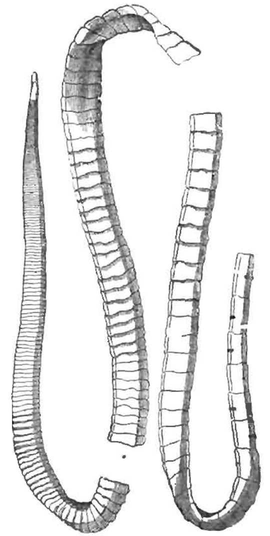

FIG. 217.—*Tænia marginata*; natural size.

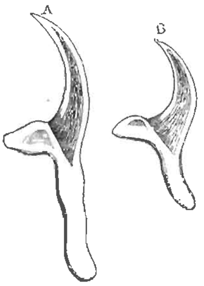

FIG. 218.—Hooks of the *Tænia marginata*; magnified 250 diameters.

Cysticercus tenuicollis by a Dog, the parasite is no more than 55 cm. to 85 cm. long, and does not yet show well-formed genital organs; it is only towards the fourth or fifth month that the last segments contain mature ova, and begin to be detached. Ingested by Lambs, they develop into the *Cysticercus tenuicollis*, which, again, may become transformed into the Tape-worm in the intestine of the Dog more than twenty-four hours after the death of its host (Baillet).

3. **Krabbe's Tænia** (*T. Krabbei* Moniez).—This species does not belong to our country. It was obtained experimentally by Moniez, in Dogs which had received Cysticerci found abundantly in the muscles of several Reindeer that

had died in the Lille Zoological Gardens. The head is larger than that of *T. marginata*; it has 26 to 34 hooks. Neck thin and short; segments broader than those of *T. marginata*, and all—except the last—much wider than long. Genital pore very developed, and occupying the entire length of the border of the segment; the latter is short, and is sometimes 1 mm. in diameter.

4. **Tæniæ cœnurus** (Kuch.).—This is a worm attaining, and sometimes exceeding—though rarely—1 m. in length. Head small, and sensibly broader than the neck; 22 to 32 hooks, the largest of which are 150 μ to 170 μ long, with the handle a little wavy on its borders and slender, and as long as the blade, which is short and wide, and the guard cordiform; the small hooks are 90 μ to 130 μ, with the handle attenuated behind and the guard entire. Segments narrower than in the preceding species, becoming square, or a little longer than they are wide, with the genital organs well developed towards the 125th, or from 15 cm. to 20 cm. from the head; posterior border straight, angles salient. Mature segments 10 mm. to 12 mm. long, and 3 mm. to 4 mm. broad; uterus formed by a median trunk of average length, having 18 to 26 slightly ramifying branches. Ova nearly spherical, and 31 μ to 36 μ in diameter.

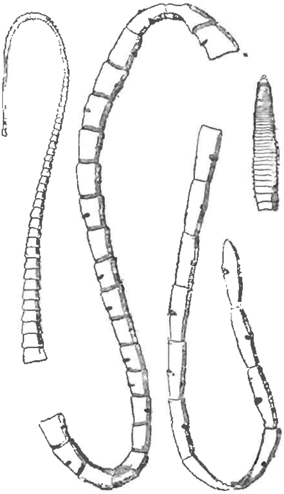

FIG. 219.—*Tænia cœnurus*; natural size.

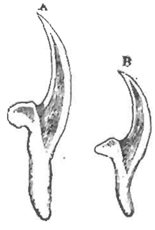

FIG. 220.—Hooks of the *Tænia cœnurus*; magnified 250 diameters.

The cystic form of this Tænia is the *Cœnurus cerebralis* Rud., which is developed in the cerebro-spinal cavity of the Sheep—more rarely in other domesticated herbivora—and causes the disease popularly known as 'gid,' 'turnsick,' etc. (Fr. *tournis*). The experiments of Küchenmeister first, and those of Haubner, Leuckhart, Baillet, etc., afterwards, demonstrated this relationship. 'Gid' appears in Lambs which have ingested the ripe segments of the *Tænia cœnurus*. Inversely, the Tæniæ are found in Dogs which have swallowed the *Cœnurus cerebralis*, and they are always numerous, the cystic

worm being provided with multiple heads. The 'gid' has, therefore, for its immediate cause, the ova disseminated by the proglottides expelled along with the excrement on pasture on which Sheep are grazed. The Dog becomes infested with the Tænia in eating the heads of Sheep affected with 'gid.' The scolex appears to require two or two and a half months' sojourn in the intestine of the Dog, before the posterior segments of the tænia have attained complete maturity.

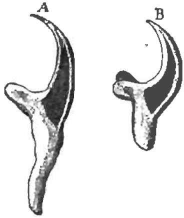

FIG. 221.—Hooks of the *Tænia serialis*; magnified 250 diameters.

A, large hook; B, small hook.

5. **Tænia serialis** (Baillet).—A worm 45 cm. to 75 cm. long. Head a little wider than the neck, and having 26 to 32 hooks, the larger of which are 135 μ to 157 μ long, with the handle wavy on its borders, and of the same length—or a little longer—than the blade; the smaller hooks are 85 μ to 112 μ long, with the handle short and the guard bilobate. Segments similar to those of the *T. cœnurus*, as well in their form as in that of the uterus; the last of them are 8 mm. to 16 mm. long, and 3 mm. to 4 mm. broad, the posterior border being straight. Eggs ovoid, and 34 μ long, by 27 μ wide.

This Tænia—which is closely related to *T. cœnurus*, has been obtained by Baillet, who caused Dogs to ingest the *Cœnurus serialis*, which he found in the connective-tissue of various parts of the bodies of some Rodents, and especially of warren Rabbits. The same authority and ourselves have met with it several times in Dogs which had not been experimented upon. The Cœnurus is developed into a Tænia in eighteen to twenty-four hours after the death of his host.

6. **Tænia echinococcus** (Sieb.). — This species is distinctly separated from all the others, more particularly by its small size. The entire chain does not exceed 4 mm. or

FIG. 222.—*Tænia echinococcus*; magnified.—Perroncito.

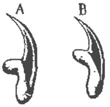

FIG. 223.—Hooks of the *Tænia echinococcus*; magnified 500 diameters.

A, large hook. B, small hook.

5 mm. in length, and only comprises 3 or 4 segments, the last of which contains the mature ova. The head has a double crown of 28 to 50 hooks, which differ but little in size in the two rows, and are all remarkable for the great development of the guard; the larger hooks are 22 μ to 30 μ long, according to Leuckart they are 40 μ to 45 μ; while the small ones are—after the same authority—30 μ to 38 μ, though they are given by others as 18 μ to 22 μ. Eggs ovoid, 32 μ to 36 μ long, by 25 μ to 26 μ broad.

This worm often escapes observation, in consequence of its small dimensions; but by close attention it can be distinguished in the form of small yellowish filaments expanded at one end, floating in the fluid contents of the intestines, and readily made visible by opening the viscus and immersing it in water. Its hydatid form is the *Echinococcus veterinorum*, which is found in most of the organs of Herbivora, and even of Man; but it is

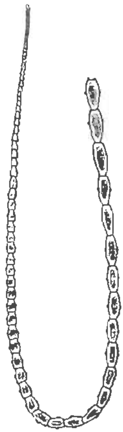

FIG. 224.—*D. caninum* of the Dog, small specimen; natural size.—Railliet.

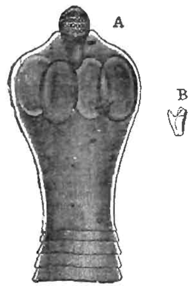

FIG. 225.—*D. caninum*.—Railliet.

A, head magnified, with the proboscis partially protruded. B, one of the hooks of the proboscis; highly magnified.

more particularly met with in the liver and lungs of Ruminants and the Pig. The experiments of Von Siebold, Leuckart, Küchenmeister, and others, have proved that the mature protoglottides, ingested by a herbivorous animal, cause it to become infested with Echinococci in various organs, and that numbers of *T. echinococcus* are found in the intestines of Dogs that have eaten viscera infested with the hydatid. In two or three weeks these Tæniæ have already two segments; in about a month the Tæniæ are fully formed—the last segment containing ripe ova; though Baillet has not been able to find mature eggs in worms 54 days old.

7. **Dipylidium caninum** (Linn.), *T. cucumerina* Bloch.—A worm 10 cm. to 40 cm. long, and 3 mm. at its greatest breadth. The head is provided with a club-shaped, very protractile rostellum, which may be retracted into a pouch in the centre of the head, between four suckers, and is furnished with four rows of very small hooks in the form of thorns of a rose-bush. Neck long and narrow. The first segments are narrow and trapezoidal in shape, the others longer than they are wide, and like melon-seeds in form (*cucumis*). Genital orifices double, and opening towards the middle of each side of the segments on a slight prominence. Ova globular, from 37 μ to 46 μ in diameter, and massed in small groups, in round, special, and contiguous capsules.

For a long time the host of the *D. caninum* in the larval state was unknown, until one of Leuckart's pupils—Melnikow, in 1869, discovered this larva—*Cryptocystis trichodectis* Villot—in a cavity in the body of the Trichodect—*Trichodectes canis*—of the Dog. It appears as a pyriform body, ·3 mm. long, dark-grey colour, enveloped in a thin membrane, and almost entirely destitute of a caudal

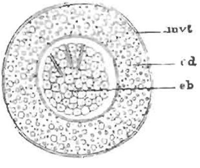

FIG. 226.—Completely developed ovum of the *D. caninum*.—Moniez.

mvt, vitelline membrane ; *cd*, delaminated layer ; *eb*, embryo.

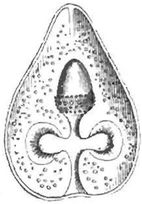

FIG. 227.—Cysticercoid (*Cryptocystis trichodectis*) of the *D. caninum*.—Leuckart.

vesicle. In its middle is seen the retracted rostellum, and on each side the invaginated suckers. Melnikow has succeeded in infesting the Trichodectes by sprinkling on the skin of a Dog—at a part invaded by these insects—the paste obtained by crushing ripe proglottides. In hunting for these parasites the Dog swallows the Cryptocysts which the trichodectes harbour, and which are transformed into Tæniæ in its intestine. They are rapidly developed there ; for in puppies ten days old they are found already measuring 25 mm. long, and in those four or five weeks old the last segments of the worm are filled with ripe ova. The Trichodectes are infested by gnawing the débris of the Tæniæ attached to the hair of the Dog.

But the Trichodect is certainly not the ordinary intermediate host of the *D. caninum*, which is infinitely more frequent in the Dog than the skin parasite ; and this fact has led Grassi to the discovery of the first normal host of this Cestode. It is the Dog Flea (*Pulex serraticeps*) which plays this part ; for the Cryptocysts are found in a free state in the abdominal cavity of this insect, which

may contain fifty of them. In giving Dogs infested Fleas, the development of the *D. caninum* constantly follows, its dimensions being related to the time that has elapsed since ingestion of the Fleas. The experimental precautions adopted by Grassi give every guarantee for the soundness of his conclusions. The number of infested Fleas is not always proportionate to that of the *D. caninum* in the Dog, as the insects pass very readily from one host to another, and in this way contagion comes into operation. The Flea that lives on Man (*Pulex irritans*) may also serve as the intermediary of the same Tænia.

It may be mentioned that the discovery of Grassi has been confirmed by Sonsino.

Mesocestoides lineatus, Gœze (*Tænia litterata* Batsch).—This Cestode has a certain resemblance to *D. caninum* by the form of its segments, which are wider in the middle than at the ends. It is slightly more transparent, and has a faint reddish tint along the middle line. But it is entirely different in its organization from the *D. caninum*. Its average length is ·30 m. to ·50 m., though it may exceed 2·50 m. The head is ·9 mm. broad, and is destitute of rostellum and hooks; its four suckers are large, with a very open longitudinal slit. The genital pores are not lateral, and are represented by two small openings, situated nearly at the middle of the ventral surface, and the vulva is a

FIG. 228.—Cephalic extremity and series of segments of *M. lineatus*; magnified six diameters.—Krabbe.

FIG. 229.—Cephalic extremity of *M. lineatus*, anterior aspect; magnified fifty-five diameters.

FIG. 230.—*M. lineatus*.—Railliet.

A, mature segment, magnified six diameters. B, ova; magnified 300 diameters.

little in front of the male orifice. The genital organs appear on the middle line as a small opaque spot, very visible to the naked eye, and—in the mature segments, measuring 3 mm. long, and 2 mm. broad—is constituted by a pyriform vesicle, situated near the posterior border; this is the uterus, filled with ovoïd eggs having a very thin double envelope, and 40 μ to 60 μ long, by 35 μ to 43 μ broad.

Rudolphi gave the designation of *T. canis lagopodis* to a closely allied form, found by Abilgaard in the Isatis—*Canis lagopus*. Krabbe has attributed to this Arctic Fox the Tæniæ found in Dogs in Iceland. Baillet—who was the first to report this Tape-worm in the Dog—named it *T. pseudo-cucumerina*,

because of its resemblance to *T. cucumerina*. Hamann classes with *T. lineata* Gœze, of the Wild Cat, a very closely related species expelled by a domesticated Dog. The presence of four suckers brings these worms towards the Tæniæ; but the situation of the genital openings allies them, on the contrary, to Bothriocephalus. It is quite natural to associate them in one special group, and Batsch has done so, naming them *Tæniæ margaritiferi*, in consequence of the uterus being flask- or pearl-shaped. They constitute, however, the subfamily of *Mesocestoidinæ*. All are unknown in their cystic form.

The eight species of Tæniæ, a summary description of which has just been given, are sometimes difficult to distinguish from one another—the first five especially. If *T. Krabbei* be excepted—because it is not likely to be observed in our country, as it has its origin in the Reindeer—an exact distinction may easily be arrived at by referring to the following table:

- Head armed. Genital pore marginal,
  - single
    - Numerous proglottides. Strobila several centimètres long. Small hooks with guard
      - bifid; hooks.
        - 230 μ to 260 μ long; genital pore very salient - - - *T. serrata.*
        - 136 μ to 157 μ long; genital pore not very salient - - *T. serialis.*
      - entire; large hooks.
        - 180 μ to 220 μ; length of the mature segments double that of their width - - *T. marginata.*
        - 150 μ to 170 μ; length of the mature segments treble their width - *T. cœnurus.*
    - 3 or 4 segments; some millimètres long *T. echinococcus.*
  - double and bilateral - - - - - - - - - - - *D. caninum.*
- Head unarmed; sexual orifices on the ventral surface - - *M. lineatus.*

The Tæniæ are extremely frequent in Dogs, and autopsies which do not furnish some are almost rare. Of 84 Dogs examined by Bertholus and Chauveau, with the object of ascertaining this frequency, only two had no traces of Tape-worm.

But the various species are far from being equally distributed, and the variation seems to pertain to countries.

At Lyons, of 84 Dogs examined by the two authorities we have cited, 23 furnished *Tænia serrata*, 11 *T. marginata*, only one the *T. cœnurus*, 6 *T. echinococcus*, 75 *D. caninum*, and 7 *M. lineatus*.

Zschokke, at Zurich, examined the bodies of 177 Dogs, and he found 61 of them—or 34 per cent.—bearers of Tæniæ; of these,

38 had *D. caninum*, 9 *T. marginata*, 7 *T. echinococcus*, 4 *T. serrata*, and 3 *T. cœnurus*.

In Schöne's examination of an average of 100 Dogs, he noted that 43 harboured *T. marginata* ; 40 *D. caninum* ; 24, *T. serrata* ; 1, 6, *T. cœnurus*. *Tænia serrata* was most frequent in sporting Dogs ; *T. marginata* in butchers' and harness Dogs ; *D. caninum* in watch Dogs ; and Sheep Dogs were the hosts of *T. cœnurus*—7 per cent.—*T. marginata*, *T. serrata*, and *D. caninum* ; while 36 per cent. of pleasure Dogs had *T. marginata* and *D. caninum*, and 16 per cent. *T. serrata*.

At Copenhagen, of 500 Dogs of all sizes and ages which were killed or had died of disease, Krabbe found *T. serrata* in only 1, *T. marginata* in 71, *T. cœnurus* in 5, *T. echinococcus* in 2, and *D. caninum* in 240.

These figures show the generally greater frequency of *D. caninum*, which we have also found to be the case at Toulouse ; then comes—as at Lyons—*T. serrata* : *T. marginata* is more rare there, and *T. cœnurus* is still rarer. The rarity of *T. serrata* is also remarked at Copenhagen, which may be explained by the fact that few Rabbits are bred there.

The frequency of Tæniæ is also related to that of the Cystic or bladder worms infesting Ruminants and Rabbits. According to Bertholus and Chauveau, the 'gid' of Sheep is altogether exceptional at Lyons. The *M. lineatus* is common at Toulouse, and in certain years one-third of the Dogs examined post-mortem have it.

In Iceland, in 93 Dogs, Krabbe met with *T. marginata* in 75, *T. cœnurus* in 18, *T. echinococcus* in 28, *D. caninum* in 57, and *M. lineatus* in 21. The abundance of the first three species in that island is owing to the large number of Sheep owned by the inhabitants. The frequency of *M. lineatus* should also be remarked ; but that of *T. echinococcus* is the most important circumstance in connection with this question. The number of Dogs in Iceland is very considerable, and as they live in the most promiscuous manner with Man, he is also frequently affected with echinococcosis. It is estimated that one-fortieth to one-fiftieth of the human population is the proportion of those who pay tribute to the disease ; and certainly this proportion must be much greater for live stock.

Thomas has also remarked on the frequency of *T. echinococcus* in Australia, he having found it in nearly one moiety of forty Dogs he examined ; these animals had been fed on offal from slaughter-houses, or on refuse flesh. This prevaleuce of Tape-worm in Dogs is related to the great frequency of Echinococci in Man and the domesticated animals in that country.

Several species of Tæniæ may be found together in the intestine of the same Dog ; for it is sufficient that the animal should have eaten flesh containing the various Cystic forms from which these Tape-worms are derived.

The number of individuals by which each of these Tæniæ may be represented in the same Dog is extremely variable. Bertholus

and Chauveau have found 1 to 64 for *T. serrata*, 1 to 7 for *T. marginata*, 1 for *T. cœnurus*, 1 to several thousands for *T. echinococcus*, 1 to more than 360 for *D. caninum*, and 1 to more than 300 for *M. lineatus*. Krabbe has also often met with *T. marginata* alone, or rarely more than 2 or 3 specimens of it, or as many as 20, and in one instance 24; the number of *T. cœnurus* was usually below 10, often above it, and as high as 30—in two instances it was from 150 to 180; that of *T. echinococcus* was always considerable—sometimes enormous; while *D. caninum* was often under 10, but in the majority of instances it was much more—as high as 100, sometimes several hundreds, and once 2,000; and there were also, ordinarily, fewer than 10 of *M. lineatus*, though in some cases there were more—sometimes 300 to 400.

These numbers, in general, quite agree with the conditions pertianing to the origin of these Tæniæ; for *T. serrata* is in variable, and usually in small number, as is also the *Cysticercus pisiformis* of the Rabbit's peritoneum, and somewhat in the same proportions; while *T. marginata* can scarcely be otherwise than in small number, as but few examples of *Cysticercus tenuicollis* are found in the peritoneum of one Ruminant. The *Cœnurus cerebralis* having numerous scolices on the inner surface of its vesicle, *T. cœnurus* should therefore always be found in troops; and the divergence between the induction and the reality may be explained by the circumstance, that the majority of the scolices are already dead when the heads of the Sheep which had been affected with 'gid' are given to Dogs to eat. The large number of *T. echinococcus* is accounted for by the multitude of scolices that contain the Echinococci. With regard to *D. caninum*, its numbers should be as large as the intestinal colonies are old; because then the chances of infestation of the fur by the parasites are increased, and, consequently, that of the Dog itself. Lastly, nothing can be said as to the *M. lineatus*, for nothing is known as to its larval condition.

Notwithstanding their extreme frequency, the Tæniæ most frequently have no influence on the health of the Dog. Sometimes, nevertheless, by their accumulation, and by the intestinal obstruction or invagination they cause, colic ensues, or symptoms of chronic intestinal catarrh are manifested. The appetite is very capricious, and passes from extreme voraciousness to absolute inappetence. Growth is checked and emaciation becomes marked; young Dogs are often uneasy, the tail is agitated, they change their resting-place very frequently, and appear to be desirous of biting the skin of the abdomen. Sometimes they drag the abdomen along the ground, cry or howl, are restless, run here and there, and even have epileptiform seizures. After these attacks, they remain dull and taciturn, or they resume their liveliness and normal state until the appearance of another crisis; and when these attacks are very frequent, convulsions set in, with cataleptic symptoms, followed by gradual sinking and death.

The existence of Tape-worm is readily recognised, in nearly every

case, by the presence of segments or joints on the surface of the fæces; and often the only symptom accompanying this indication is pruritus, due to the presence of fragments of strobila arrested near the anus, which compels the animal to rub this region against the ground in moving along in an attitude altogether peculiar and characteristic.

The nervous symptoms that a Dog affected with tæniasis may exhibit have sometimes a certain resemblance to those of rabies. In 1862, Pillwax considered the *T. echinococcus* as capable of inducing rabiform fits, by the intestinal pain it caused. He had only met with that parasite on three occasions, and then in Dogs which had been killed as rabid, and which, at their autopsy, showed the same lesions as those observed in Dogs really rabid. In the same Dog he found millions of these worms entirely covering the mucous membrane of the small intestine, into which they were implanted by their hooks, and so firmly that in attempting to pull them off the strobila was usually removed, but the head remained. Bollinger has published a similar observation; and one of Leisering's experiments appears to confirm Pillwax's opinion. He gave a Dog a large quantity of Echinococci taken from the liver of an Ox. Six weeks afterwards this animal exhibited symptoms of rabies, tendency to bite, harsh and husky voice, refusal of food and water, dulness, debility, and wasting; death occurred on the fifth day. At the autopsy, the small intestine was observed to be much congested, and every part of the mucous membrane was covered with an immense number of Tape-worms. But this experiment is not reliable, as nothing is said with regard to the antecedents of the Dog, and proof-tests by inoculation were not made—no more than in Pillwax's cases—in order to ascertain whether there was merely a coincidence between the worms and true rabies; because similar symptoms were not noted in the numerous and varied experiments made on the development of *T. echinococcus* by the ingestion of the hydatids.

The facts collected by Cagny and Benjamin are more conclusive, and do not concern *T. echinococcus*, but the large Tape-worms without distinction of species. The physiognomy, and the agitated condition of the Dogs, certainly resembled rabies, as well as the desire to bite either people, straw, or other matters; but one was cured by the administration of a vermifuge, and at the autopsies of two others the intestines were obstructed by bundles of Tape-worms. Besides it is well known in human medicine, as well as that of animals, that lesions of the stomach or intestine may be betrayed by different kinds of vertigo; but investigations are required in this direction to establish the reality of the relations between rabies and tæniasis. An observation by Cadéac—mentioned below—is very demonstrative in this respect.

Waldteufel has also published an interesting case of a Dog affected with a serious helminthiasic cachexia—due to Ascarides and *Tænia cœnurus*—the animal also showing a circling movement

(*mouvement de manège*) and rabiform vertigo. The disappearance of these symptoms coincided with the evacuation of a mass of intestinal parasites.

The autopsies of Dogs attacked with tæniasis, generally only show the parasites lodged in the small intestine. According to the time that has elapsed since death, they may have wandered more or less beyond this, and in small numbers, into the stomach or large intestine. Krabbe has always met with the *T. cœnurus*, *caninum*, and *lineatus* in the posterior moiety of the small intestine, and *T. echinococcus* in the anterior moiety. We have made the same observation.

Inflammation of the mucous membrane, croupal enteritis (Eberth), invagination, and obstruction by coils of Tape-worms, may be discovered; but it is altogether exceptional to find perforation of the intestinal wall, though cases reported by Schiefferdecker, Cadéac, and Lahogue demonstrate the possibility of this lesion taking place.

The first of these authorities found a prodigious quantity of *D. caninum* in the small intestine of a Dog. There was considerable hypertrophy of the papillæ of the small intestine—which was very hyperæmic—and more than four or five times the size of normal papillæ. In the layer of Lieberkühn's glands were excavations or tunnels running parallel to the axis of the intestine, which contained segments of Tæniæ 3 mm. to 6 mm. long, and 2 mm. to 3 mm. broad; each gallery held two or three parasites, but most frequently only one. The walls of these tunnels were formed by the normal glands of Lieberkühn, their floor by widened and curved glands, and their roof by hypertrophied papillæ fused together as a consequence of shedding of their epithelium.

At the autopsy of a Dog which had been killed after exhibiting the physiognomy of rabies, Cadéac found two Tæniæ (*serrata*) placed, one in the non-inflamed peritoneum, the other fixed in a perforation of the small intestine, its anterior extremity floating in the abdominal cavity—the worm being retained in the intestine by the proglottis, which could not pass through the opening. The fistulous perforation was infundibuliform at its intestinal orifice, and salient at its peritoneal opening, its walls being formed of embryonic tissue at least some days old. Inoculation of a Rabbit with the medulla oblongata of the Dog had no result, showing that it had not been a case of true rabies.

An anæmic Dog having been killed under suspicion of rabies, Lahogue found in its small intestine a considerable quantity of *T. serrata*, and in the duodenum three small perforations surrounded by an inflammatory ring, in each of which was fixed a Tape-worm, floating by its free portion in the peritoneal cavity.

Caparini attributed to the presence of numerous *D. caninum*, a violent attack of enteritis in a Dog which had previously ingested cystic Echinococci; but there is nothing here to prove the noxious influence of the Tæniæ.

The Tape-worms are not, therefore, absolutely free from inconvenience to the Dog, and it is advisable to free that animal from them, in order to prevent accidents which they might occasion; and this is the more to be urged in view of the possible infestation of Man and the domesticated herbivora by the Cystic or bladder worms resulting from these Tæniæ. This recommendation is particularly applicable to Sheep Dogs that go among grazing flocks, and to those which—rare in our country—live in such close com-

panionship with Man, that the proglottides expelled along with their excrements may contaminate the water he consumes.

The administration of a tæniafuge should be preceded by a fast for twenty-four hours; enemas may also be useful.

Many tæniafuges have been proposed and employed.

The ethereal extract of male fern is certainly one of the best, and 2 to 8 grammes in capsule or pill produce a prompt result. Trasbot states that remarkable effects are obtained by mixing the extract and the tincture—2 to 8 grammes and 18 to 40 grammes. But this preparation has the inconvenience of being very irritating to the intestine, and to require the addition of a large proportion of *some excipient. An excellent mode of administration is that* practised at the Toulouse clinic; the dose varies according to the weight of the animal—about 15 grammes for a Setter—and is mixed with a dose of castor-oil, which is also proportionate to the weight of the Dog. The evacuation of the Tape-worms is almost certain, and often takes place within an hour after the remedy has been administered.

Trasbot also recommends birch-seeds (*graine de bouleau*), given in milk for four or five days, in doses of 10 to 50 grammes, as an excellent and perfectly safe agent. Delabere-Blaine recommends oil of turpentine, 2 to 4 grammes, given in yolk of egg for some days.

Kousso is particularly serviceable. It is given in doses of 10 to 30 grammes, the flowers being pulverized, and mixed with 35 grammes of sugar in some spoonsful of infusion of tilleul; or the flowers are infused for a quarter of an hour in one-fourth of a litre of warm water, and the whole is administered when the animal is fasting. An effect is produced in about two or three hours.

Pomegranate-root bark is also efficacious, employed in doses of *50 to 150 grammes in decoction with 750 grammes of water, reduced* to 500 grammes. Three doses of this are given at intervals of an hour. The fresh bark is to be preferred, as being more certain. Treatment is completed by the administration of a purgative—30 grammes *of castor-oil—three hours after the last dose.*

For twenty years kamala has held an important place among tæniafuges, and it is also a purgative. It is given in 3 to 10 grammes in pill, and it may be useful to repeat the dose two or three days later. Areca-nut in powder is a good tæniafuge for the Dog. The nut should not be more than a year old. The powder is given in doses of 2 to 10 grammes, mixed with butter in the form of pills. The Tæniæ are ejected in a few hours afterwards—rarely longer than 18 hours; but if no effect is produced in about 2 hours, the action of the drug may be expedited by a dose of castor-oil. Areca-nut has the inconvenience of being often vomited by the Dog.

Delamotte has constantly obtained expulsion of Tape-worms by the employment of sulphuret of calcium, in doses of 1 to 5 grammes for young Dogs, 3 to 5 for adults. A purge of castor-oil is given an hour afterwards.

Powdered areca-nut or 'tænaline' is perhaps the most employed,

in doses of 15 grains to 2 drachms—about 2 grains for every pound of the Dog's weight—mixed in linseed oil, soup, mucilage, the ordinary food, or, best of all, milk. Previous to the administration, the bowels should be emptied by giving a simple laxative, and then the animal should be kept without food for several hours. Sometimes the areca-nut powder is combined with 10 to 15 minims of male fern extract, and this mixture is said to be the most effectual remedy for Tape-worm in Dogs. If the parasites are not removed, a second dose is advisable several days later, when, should the results be still unsatisfactory, and the bowels not much relaxed, a moderate dose of castor-oil and buckthorn will sometimes bring away worms that were previously immovable.

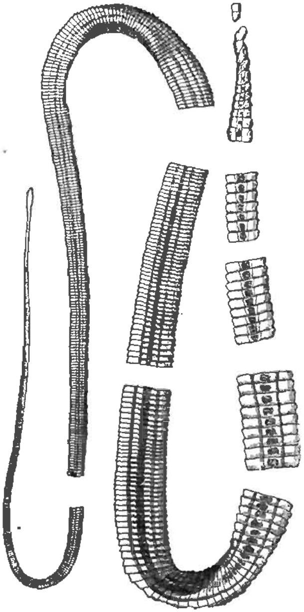

FIG. 231.—Portion of a *Bothriocephalus latus.*—After Leuckart.

Bothriocephalus. — The best-known species is the **Bothriocephalus latus** (Bremser — Figs. 154 to 156, 231 to 235). It is a worm usually 2 m. to 7 m. long, but it may reach 20 m. It is of a greyish tint. The head is oblong, lanceolated, and unarmed, and is furrowed for nearly its entire length by two lateral slits—or fossæ — that play the part of suckers. The neck is scarcely marked, and the first segments are barely visible, but those that follow are soon distinguished by their length, which goes on increasing—though it is always less than their breadth, which gradually attains 2 cm., while the length never exceeds 4 mm. to 5 mm.

When they have reached complete maturity, they lose their breadth, and the strobila with them; at the same time, they diminish in length—a modification which is due to atrophy of the genital organs, and their depletion by ovulation. In fact, the segments of the Bothriocephalus do not separate from the chain like those of the Tæniæ, to throw off their eggs by rupture of the tissues. There is a real ovulation through an opening situated near the middle of the ventral surface. In front of this is seen a small tubercle, on the summit of which is pierced the male opening, and, immediately behind it, the female opening. The eggs are ovoid, operculated, and 68 μ to 71 μ long, by 44 μ to 45 μ broad. The embryo is only developed after the egg is laid; it is hatched in water during

several months. It is globular, covered with a ciliated envelope, from which it issues by a rupture it makes, and then appears with all the characters of a six-hooked embryo of the Tæniæ.

During its intestinal existence, the Bothriocephalus throws off, from time

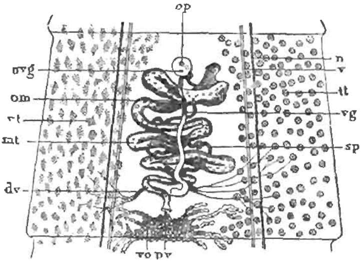

FIG. 232.—Diagram of a segment of the *Bothriocephalus latus*, seen on the ventral surface.

v, vessel ; *n*, nerve ; *tt*, testicles ; *sp*, spermiduct or vas deferens ; *op*, orifice of the penis ; *vo*, ovary ; *pv*, pavilion ; *mt*, uterus ; *om*, opening of the uterus ; *vt*, vitellogenous follicles ; *do*, vitelloduct ; *vg*, vagina ; *ovg*, opening of the vagina.

to time, fragments of various lengths, which are nearly empty of eggs, and are more or less shrivelled and twisted.

This species more particularly infests Man, chiefly in the lake districts of French Switzerland, in the North of Italy ; on the shores of the Baltic, Finland, and Sweden ; in a small portion of Poland ; in Denmark ; and in Greenland ; and it has also been observed here and there in every European country. Switzerland and the Baltic provinces of Russia appear to be the countries in which this worm is most frequently observed in Man ; and in these much fish, caught in the great freshwater lakes, is eaten. It seems to be extremely

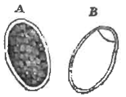

FIG. 233.—Ova of the *Bothriocephalus latus*.—Laboulbène.*

FIG. 234.—Ciliated embryo of the *Bothriocephalus latus*.—Leuckart.

* A, seen in glycerin ; B, seen after being acted upon by sulphuric acid, which renders the operculum apparent.

rare in the United Kingdom, and in countries beyond Europe where there are similar lakes—as on the American continent. Dr. Drivon, of Lyons, who has recently written on intestinal worms, observes that the spread of the

parasite beyond its two favourite localities has been noted by several recent authorities. In 1883 and in 1890, Dr. Drivon himself observed a case in Lyons. In the first case, the patient had never been to Switzerland, and had not gone further from Lyons than Mâcon for years. A specimen of *Tænia saginata* was passed by the same patient. In Dr. Drivon's second case, the patient had never been further than Vienne on the Rhone. The Bothriocephalus has been observed within the last twenty years in Paris, Vincennes, St. Malo, Utrecht, Piedmont, Milan, and Bavaria. The Lake of Starnberg, which supplies fish to Munich, seems to have become infected about 1879, by tourists who had resided for some time near the Lake of Geneva. On the other hand, the parasite is becoming rarer in Switzerland. Not many years ago it used to be said, that no good citizen of Geneva was without his Tapeworm; and a distinguished authority was the 'host' of several samples of the Bothriocephalus, very shortly after he became the guest of that city. The same authority, revisiting Geneva a few years ago, had great difficulty in procuring a single specimen of the Bothriocephalus for purposes of experiment. The explanation of the welcome disappearance of the parasite from Geneva is by no means clear. The larva appears to choose by preference the Pike, Turbot, and Perch, but it has been found in Tench, Grayling, and other fishes.

The history of its development is still incomplete. For a long time, the opinion most general was that the Bothriocephalus must pass through an intermediate host, which was a fish. The persevering researches of Braun confirmed this opinion; for he found the Pike and Burbot to have their intestines, muscles, and different tissues infested with the agamous Worms—*Plerocercoïdes*—always destitute of an adventitious capsule, with an invaginated head, and without a posterior appendage. In feeding Dogs and Cats with these larvæ, and keeping them away entirely from any other cause of infection, Braun has always found the *Bothriocephalus latus* in these animals. Parona and Zschokke have, in their turn, remarked the presence of these larvæ in the Pike, Burbot, Char, Grayling, common Trout, and the Fera. Parona, Ferrara, Grassi and Rovalli have experimentally demonstrated the transformation of these larvæ into Bothriocephalus species, in the intestine of the Dog and Man.

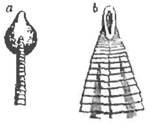

FIG. 235. — Head of the *Bothriocephalus cordatus*, seen in front and in profile. —Leuckart.

The *Bothriocephalus latus* has also been found in the Dog, exclusive of experimental conditions. Linné and Pallas had already noted this, and their observation was confirmed by Von Siebold, Krabbe, Perroncito, Braun and others.

Bothriocephalus cordatus (Leuck.).—The maximum length of this worm is 1·15 m.; but it usually has not more than about 400 segments. The head is short, broad, flattened laterally, and has a deep pit on each surface, dorsal and ventral. No neck. Segments rapidly widening, the mature ones being 3 cm. from the head, and 3 cm. beyond this they attain their greatest width, which is from 7 mm. to 8 mm. The calcareous corpuscles are very numerous.

This species is special to Greenland, and has been only once found in Man; but in that country it is frequent in the Dog, one animal sometimes being the host of several specimens. Olrik has collected twenty from six Dogs, and Pfaff twenty-four in three others. Pfaff has also found the worm in a Seal (*Phoca barbata*), and Zimmer has met with it in a Walrus. The presence of this Cestode in Mammalia which are essentially ichthyophagous, demonstrates that its larval stage is passed in a fish.

Bothriocephalus fuscus (Krabbe).—A worm measuring 1 cm. to 80 cm. long. Head compressed and lanceolated. First segments scarcely visible, and appearing at some distance from the head or immediately behind it. Their breadth increases regularly from ·5 mm. to 5 mm., then it diminishes, the segments becoming longer—often longer than broad. The uterus appears

in their centre as a dark-blue spot, the colour being due to the eggs it contains. There are no calcareous corpuscles.

Krabbe has found this worm in the intestine of two Dogs in Iceland. In one Dog there were 22 worms of different sizes.

The same authority has given the names of *Bothr. reticulatus* and *Bothr. dubius* to two forms that he discovered also in Dogs, and as both appeared to be closely related to *B. fuscus*, he hesitated to separate them from it.

TREMATODES.—Two species of Trematodes—a Hemistomum and an Echinostomum, both very rare—have been found in the intestine of the Dog.

Hemistomum alatum (Gœze).—The length of this worm is 3 mm. to 6 mm., the colour is dirty-white; the anterior part is dilated in a heart-shaped manner, and formed as if it had a kind of horn on each side. It is common in the Fox and Wolf, and has been found in the Dog by Creplin and Schöne. The latter has only met with it in draught Dogs—5·5 per cent.

Echinostomum echinatum (Zeder).—Body red or rosy in colour, 4 mm. to 15 mm. long, and seven times less broad, lanceolated, flat, prolonged in front by a narrow and very short neck, terminated by a head or reniform dilatation, notched below, and surrounded by straight spines over all the remainder of its contour. Integument studded by small spines or sharp lamellæ on the anterior part, and by obtuse lamellæ on the posterior part. Ventral sucker three or four times larger than the oral one. Ova of a brownish-yellow hue, 94 μ to 110 μ long, and 75 μ broad (Dujardin).

FIG. 236.—*Hemistomum alatum*; natural size and magnified.—Gurlt.

This species, which is somewhat common in the intestine of domestic Ducks and other aquatic Birds, has been found by Generali in the duodenum of a Dog; the intestine was very inflamed, and dotted by a great number of yellowish-grey spots. This species is interesting, because of the complete researches of which it has been the object on the part of several experimentalists, especially Pagenstecher, and more especially Ercolani. Railliet has given a *résumé* of these investigations, from which we learn the following history:

The larval forms of the *Ech. echinatum* are those most commonly observed in aquatic molluscs, and especially in the Limnæa, planorbis, and paludina. They are met with in very diverse organs, and in these conditions their characters are so variable as to lead to the belief that there are several specifically distinct forms. Such is the origin of the *Cercaria echinatoides* Fil.—identical with *C. echinifera* La Val—and of *C. spinifera* La Val. The germinal sacs of this species are the rediæ (Fig. 237, No. 1), which develop by gemmation in their interior from other rediæ or cercariæ, and are even sometimes reproduced by external budding or by fission (No. 2). Leuckart, however, rather suspects the correctness of this observation of Ercolani relative to the multiplication of the redia by budding or by division. The rediæ vary much in their shape, as do also the cercariæ that they have formed—at least, those that are free, though they resemble them as soon as they are encysted. In certain cases these cercariæ quit the body of the Mollusc which harboured the redia, to become encysted in the skin or around the heart of paludines, while in other instances they encyst themselves as soon as they leave the redia, or even in its interior (No. 1). In administering these encysted cercariæ to cold-blooded animals—Frogs, Toads, or Snakes—no result is obtained; on the contrary, they are transformed into Distomes when they are ingested by warm-blooded animals. The experiments of Ercolani were more particularly made on Ducks, and in these creatures the later forms of the cercariæ above indicated all yielded the *Ech. echinatum*. With Sparrows, Mice, Rats, Moles and Dogs, the same species has been obtained; but with very remarkable morphological variations (Nos. 7, 8). Van Beneden was probably in error in classing *Cercaria Brunnea* Dies, with the cercariæ by which he had obtained the transformation into *Ech. echinatum* in the intestine of the Duck.

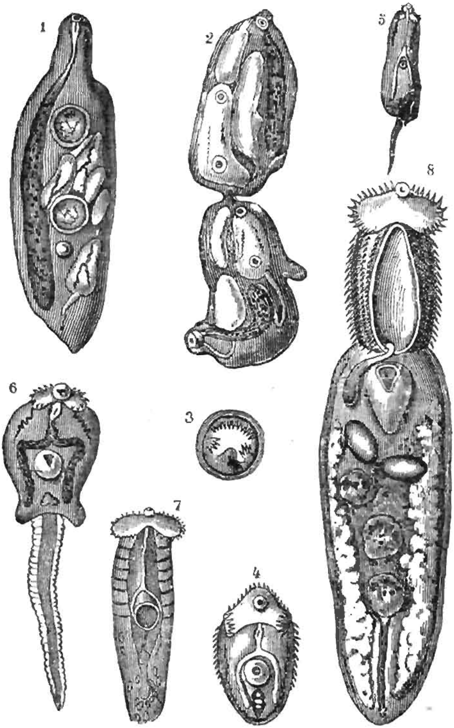

FIG. 237.—Phases of evolution of the *Echinostomum echinatum* in the intestine of the Duck.

1, redia containing free and encysted cercariæ; 2, multiplication of the redia by fission; 3, *Cercaria echinata* encysted, from the heart of the viviparous Paludine; 4, the same liberated from its cyst; 5, one of the small-tailed forms of the same cercaria; 6, one of its large forms; 7, *Ech. echinatum,* developed in the intestine of the brown Rat; 8, the same developed in the intestine of the Duck.

NEMATODES.—**Ascaris mystax** (Zeder), **A. marginata** (Rud.).—This species is considered at present, by the majority of helminthologists, as a mere variety of the ascarid of the Cat, var. *canis*, from which it is scarcely different except in being a little larger.

The body is white or reddish; head usually curved, and provided with two membranous lateral wings, broader behind than in front, which cause it to look like an arrow-head. Each of the three lips has a salient papilla. *Male*, 5 cm. to 10 cm. long; tail curved, having two small membranous lateral wings, and 26 papillæ on each side, five of which are post-anal. *Female*, 9 cm. to 12 cm. long; obtuse tail, vulva situated towards the anterior quarter of the body. Ova almost globular, and 75 μ to 80 μ in diameter.

These worms are more especially frequent in young Dogs, which may be infested with them at three or four weeks old, and even

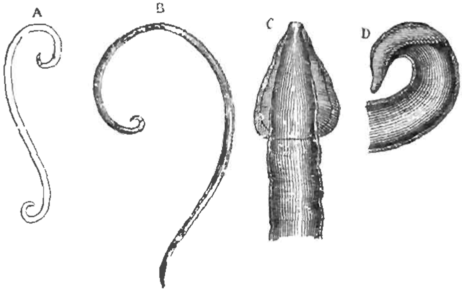

FIG. 238.—*Ascaris mystax* of the Cat.—Railliet.
A, male, and B, female; natural size, lateral view. C, anterior extremity, magnified, and seen in front, to show the lateral wings; D, seen in profile.

earlier, according to Hering; but it is towards two or three months that they are most abundant. In 500 Dogs examined by Krabbe at Copenhagen, 122—or 24 per cent.—had them; Schöne carried this proportion to 37 per cent. They inhabit the small intestine, and frequently the stomach, causing the vomition of glairy matter, in which they are found. Their presence is indicated by the same signs as those of the Tæniæ—emaciation, unthrifty coat, enlarged abdomen, irregular appetite, sometimes symptoms of epilepsy or rabiform trouble, colics, and constipation or diarrhœa. In collecting in masses in the intestine, they may cause complete obstruction, arrest the course of the alimentary matters, and induce invagination and fatal colic.

At the autopsy of Dogs which have succumbed to the disorders caused by the Ascarides, the intestinal mucous membrane is tumefied and catarrhal, and shows numerous small, round, black

points, in the centre of which is an ulcerous depression surrounded by a salient zone; and an intense hæmorrhagic enteritis, with fissures and excavations having ulcerated borders—the process involving all the coats of the intestine—has also been observed (Friedberger and Fröhner).

The observations and experiments of Hering and Mégnin lead to the belief that—contrary to the hypothesis of Linstow—the Ascarides, and particularly those of the Dog and Cat, have no intermediate host, and are directly developed. This conclusion is strongly fortified by the experiments of Grassi.

Against the Ascarides of the Dog, the various remedies recommended for Tæniæ may be employed. Areca-nut is particularly useful, though santonin is most frequently employed in 2 to 3 centigramme doses, given in milk. Zürn also recommends benzine —1 to 7 grammes—in pills or in oil. Santonin, conjoined with extract of male fern, repeated twice a week, and followed by a laxative, is the treatment generally advised in England.

Oxyuris vermicularis (L.).—Zürn states that this parasite of the human intestine may be exceptionally found in the Dog. The male is 2 mm. to 3 mm. long, the female 9 mm. to 10 mm., the colour being white, and the body expanded anteriorly. Zürn's affirmation is not corroborated, and Railliet thinks that perhaps he refers to the *Oxyuris compar*, which is a parasite of the Cat.

Anchylostomum trigonocephalum Rud. (*Dochmius trigonocephalus* Rud.).—Body white; buccal capsule slightly expanded, the ventral wall having on each side of the middle line a complex chitinous layer or 'jaw,' the free extremity of which terminates in three hook-shaped teeth in the interior of the mouth, which decreases in size from the dorsal to the ventral surface. On the dorsal border there are, in addition, two small straight teeth, separated by a median rounded depression. Two opposite lateral papillæ at the posterior third of the œsophagus. *Male*, 9 mm. to 12 mm. long; caudal pouch trilobate, the middle lobe being slight. *Female*, 9 mm. to 21 mm., most frequently 15 mm. to 20 mm. long; tail obtuse, and prolonged by an acute mucron; vulva towards the posterior third of the body. Eggs ovoïd, and 74 μ to 84 μ long, by 48 μ to 54 μ broad.

This species inhabits the small intestine of the Dog and Fox, in company with the worm next to be described. They fix themselves on the mucous membrane, and live on the blood they extract. In certain cases they are very numerous, and induce an affection analogous to that produced in Man by the 'Ankylostomum duodenale' (Dubini), and designated—according to the countries in which it appears—as *Egyptian chlorosis*, *intertropical anæmia* (America), and *miner's anæmia*—a condition which has been particularly well studied by Perroncito, whose writings so inspired Railliet and Trasbot that, from 1879, they attributed to the presence of the *Anch. trigonocephalum* that form of anæmia with which packs of hounds are often attacked. Mégnin has especially drawn attention to this *Pernicious Anæmia of Hounds*, *Uncinariosis*, or *Ankylostomiasis*, which has also been designated—because of one of its most ordinary symptoms—*Bleeding at the nose of packs of Dogs*.

Symptoms.—The symptoms are those of grave anæmia. In the first period there are only debility and wasting, always increasing,

although the appetite remains unimpaired. The Dogs are less ardent in hunting, and are even dull and indifferent; the coat is staring, the skin scaly or reddened with erythematous patches—especially at the stifles and nose; the latter is tumefied, cracked, rough, and excoriated, with a muco-purulent or sanguinolent discharge from the nostrils. Later, veritable *epistaxis* supervenes—the blood being foamy and bright red, or merely rosy—the Dog at each bleeding losing perhaps two or three ounces. These attacks of nasal hæmorrhage are separated by intervals of some days to several weeks, during which the discharge is again muco-purulent or

FIG. 239.—*Anchylostomum trigonocephalum*, male and female coupled; natural size.

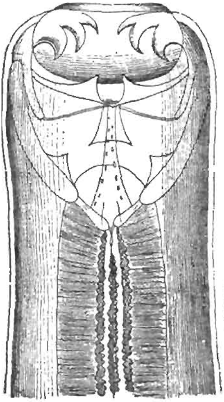

FIG. 240.—Cephalic extremity of the *Anchylostomum trigonocephalum*, dorsal surface; magnified 150 diameters.—Railliet.

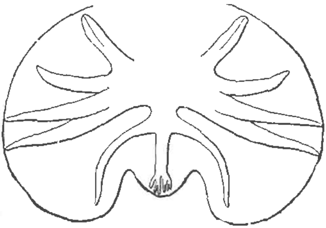

FIG. 241.—Caudal pouch of the *Anchylostomum trigonocephalum*; magnified fifty diameters; semi-diagrammatic.

sanguinolent. There is a diminution of the red corpuscles, and leucocytosis is marked. When the anæmia is rapidly developed, it is sometimes accompanied by convulsions.

Another important symptom is the œdematous and indolent *engorgement* of the limbs; this is at first intermittent, then it becomes permanent and increases in extent. In the last stage there are ulcerations, sweatings, and gangrenous patches. A diarrhœa—which has perhaps already become confirmed—gradually grows persistent, and gives place to dysentery; the appetite, after having been capricious, disappears. The animals—feeble, emaciated, and miserable, covered with red patches and excoriations—remain

constantly lying, and finish by dying in a comatose condition or in convulsions. Death takes place in a few months, or even in a year. The malady is perpetuated in kennels which have once been invaded, if energetic measures are not adopted.

Lesions.—At the autopsy of Dogs which have died from Anchylostomiasis, or have been sacrificed in the last stage, all the alterations of cachexia are observed, and particularly hypertrophy of the mesenteric glands. There are, besides, the lesions special to the malady, localized in the mucous membrane of the small intestine and cæcum. This membrane is very much thickened, and marbled by large reddish patches; its villi, quintuple their normal size and highly injected, are closely packed together. These alterations begin in the duodenum, and thence extend to the other portions of the small intestine. In the relatively healthy parts are seen a multitude of small hæmorrhagic points, and in their vicinity or centre are noticed one or more of the parasites—often coupled; their number is all the greater the larger the extent of healthy membrane, and it is consequently larger in Dogs which have been ill for only a short time, than in those in which the malady is chronic. In the latter there may be merely a few parasites in the ileum—a circumstance which may raise a doubt as to the anæmia being due to helminthes.

The *Anchylostomum stenocephalum* is mixed with the *Anch. trigonocephalum*; and the cæcum often contains, in addition, a great number of species of Trichocephalus.

Diagnosis.—This affection is easily mistaken for essential, non-parasitic anæmia, which also attacks packs of Dogs; so that the diagnosis really depends upon the discovery of ova of the Anchylostomes—which should be abundant in Anchylostomiasis after the exhibition of anthelmintics. These drugs, of course, would be inefficacious in ordinary anæmia; but in that due to parasitism they should cause numerous worms to be expelled, and these are readily seen in the fæces, while a beneficial change will be observed in the affected Dogs. The autopsy of one of these will often remove all doubt as to the nature of the malady. The Linguatula in the nasal cavities may—although rarely—cause epistaxis; but then the blood is bright-red, there are frequent fits of sneezing, and the general health is scarcely disturbed.

Etiology.—Pernicious anæmia scarcely ever attacks any but sporting Dogs, and more especially those which live in packs. It does not appear to affect any one breed more than another, but seems to attack, almost exclusively, it is said, cross-bred Dogs—French and English crosses. Dampness is one of the conditions that favour the extension of the disease, and causes it to assume an epizoötic form, when it often destroys or gravely compromises the welfare of valuable packs. Leuckart has studied the evolution of the *Anch. trigonocephalum*, and it appears that this parasite is analogous in its general characters to the Anchylostome of Man, as established by the researches of Perroncito.

The vitellus of the ova of *Anch. trigonocephalum* segments in the oviduct of the female until it reaches the *morula* stage; their evolution is not continued in the intestine of the Dog, but after their expulsion with the fæces. But on incubating in water at a suitable temperature, an embryo soon becomes visible in their interior, and hatching is completed in two or three days. The rhabditiform larvæ that issue from the ova are 300 μ long and 95 μ broad; their posterior extremity is elongated into a tapering tail; in growing they moult two or three times, and they attain the adult condition in passing—with the water—into the intestine of the Dog, without requiring an intermediate host. Eight days after this passive migration they are ·5 mm. to 1 mm. long, and in certain details of organization they resemble the definitive form, but in all probability without having undergone another moulting. On the ninth or tenth day, the old chitinous integument is shed, the buccal

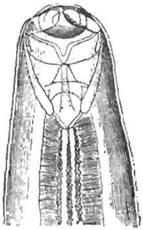

FIG. 242.—Cephalic extremity of the *Anch. stenocephalum*, viewed on the dorsal surface; magnified 150 diameters.—Railliet.

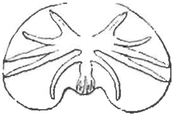

FIG. 243.—Caudal pouch of the *Anch. stenocephalum*; magnified fifty diameters; semi diagrammatic.—Railliet.

capsule appears, and it is only now that the group to which the parasite belongs can be recognised. It retains this form for three or four days, during which it acquires its final dimensions, and a second moulting results in the parasite acquiring its sexual individuality. These details, and particularly the part water plays in the evolution of the *Anch. trigonocephalum*, show that infestation probably takes place through the medium of the drinking water, and that Dogs contaminate each other by scattering the ova of their parasites in the water-troughs of their kennels.

Treatment.—When pernicious anæmia appears in a pack, extreme care should be exercised with regard to cleanliness of the kennel—flushing it out thoroughly with water to wash away the ova, and watching the animals so that they only drink pure water, and that which has not been soiled by the diseased Dogs, feeding them in buckets or troughs washed after each meal, and isolating the sick as much as possible.

Medical treatment consists in the employment of anthelmintics. Mégnin recommends kamala in doses of 3 to 4 grammes, with the

addition of ·5 gramme of calomel, and arsenic 5 to 6 milligrammes. Perroncito has obtained remarkable success in the parasitic anæmia of miners, with the ethereal extract of male fern in doses of 15 to 30 grammes—which also answers perfectly well in Anchylostomiasis of the Dog, in doses and conditions as indicated for tæniasis. The strength of the animals should be most sedulously maintained by good and easily-digested food, such as milk, and especially raw horse-flesh, with cod-liver oil, tonics—iron, gentian, etc.

Anchylostomum stenocephalum (Raill.).—'Body thinner than that of the preceding species. Head narrow; buccal capsule having on each side of its ventral wall a chitinous layer with a sharp border, beneath which is a hook-shaped tooth. The dorsal border has a middle depression, but no salient teeth. *Male*, 6 mm. to 8 mm. long, caudal pouch trilobate, the middle lobe being slight. *Female*, 8 mm. to 10 mm. long; tail prolonged by an acute mucron; vulva placed towards the posterior third of the body. Eggs ovoid, and 63 μ to 67 μ long, by 32 μ to 38 μ broad.'—Railliet.

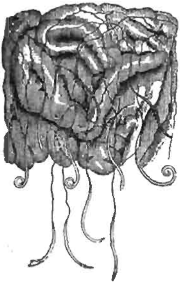

FIG. 244.—Fragment of the cæcum of a Dog in which are fixed a number of *Trichocephalus depressiusculus*: natural size.—Railliet.

This species has been found by Railliet, in company with the *Anch. trigonocephalum*; and it appears to play as active a part as its congener in the development of anæmia in packs of sporting Dogs, so that it has its share in the preceding considerations.

Trichocephalus depressiusculus (Rud.).—This species has a great resemblance to the *Tr. affinis* of Ruminants and the *Tr. dispar* of Man. The *male* and *female* are each 45 mm. to 75 mm. long. The spicule of the male is longer than in *Tr. affinis*, and its tubular sheath has blunt spines only in the moiety nearest the cloaca, the remainder being smooth. The ova are 70 μ to 80 μ long, and 32 μ to 35 μ broad.

The *Trichocephalus depressiusculus* lives in the cæcum of the Dog, in which it is not rare. It is often found in animals affected with the pernicious anæmia just described, but it does not appear to have any other than a secondary part in the development of the disease. We have always found it in essential anæmia. Mégnin states that, when in considerable number on the surface of the mucous membrane of the cæcum, it causes an inflammatory tumefaction of that organ—a veritable typhlitis or appendicitis—sometimes accompanied by its invagination.

Railliet has succeeded in obtaining experimental development of the Trichocephalus of the Dog. The ova of this species, when collected in February and placed in water, took five months to produce complete embryos; and when ingested by a Dog, these became species of Trichocephalus, and attained complete development in about three months. This experiment confirms those of

Leuckart on the *Trichocephalus affinis* of Ruminants, and the *Tr. crenatus* of the Pig; and it shows that the Trichocephalus species are directly developed without any intermediate host, that their embryonic development takes place entirely outside the body of an animal, and that they must pass into the digestive tube of their host while still enveloped in their shell. It also establishes the fact that embryonic evolution is altogether suspended by desiccation, and explains the facility with which spontaneous infestation can occur. Railliet has found in the jejunum of a Ferret a female Trichocephalus that appeared to belong to the same species as that of the Dog.

'**Filaria hepatica** (Cobbold).—Cobbold gave this name to worms found by Mather, encysted in the intestinal wall and biliary ducts of a Dog, which had died in consequence of gastritis and duodenal invagination. It was probably only a larval form.'—Railliet.

ARTICLE VII.—Parasites of the Intestine of the Cat.

COCCIDIA.—*C. bigeminum var. cati*, like the *C. bigeminum* of the Dog, lives in the interior of the intestinal villi; it is much smaller (8 μ to 10 μ long by 7 μ to 9 μ broad) than the Coccidium of the Dog, and appears to have no greater influence on the health of its host. It was first seen by Finck, who attributed to it a rôle in the absorption of fatty matters. Labbe doubtfully attached to this species the *C. Rivoltæ* (Grassi), which differs from it inasmuch as it develops in the epithelial cells, measures 27 μ to 30 μ long by 22 μ to 24 μ broad, and falls into the intestine after the rupture of the invaded cell.

INFUSORIA.—There is found in the Cat—though rarely—a flagellated Infusorian—the *Lamblia intestinalis* R. Bl., which has been already mentioned among the intestinal parasites of the Sheep and Dog. It prefers the duodenum and jejunum, and often attaches itself by its sucker to the intestinal epithelial cells. It does not appear to cause any inconvenience to its host.

CESTODES.—Three species of Tæniadæ and a Bothriocephalus live in the intestine of the Cat. Of the three Tæniadæ, one is a true tænia, the second is a Dipylidian, and the third is a species of *mesocestoïdes*.

1. **Tænia crassicollis** (Rud.).—This is a worm 15 cm. to 60 cm. long, and offering the general characters of the Cystotænians of the Dog. The head is hemispherical, 1·7 mm. broad, with a powerful rostellum; the neck is as wide as, or wider than, the head, and there is no constriction between them. There is a double crown of 29 to 52 hooks—most frequently 34—the larger of which are 380 μ to 420 μ long, and the smaller from 250 μ to 270 μ. The last segments are 8 mm. to 10 mm. long, and 5 mm. to 6 mm. wide. Ova globular, and 31 μ to 37 μ in diameter.

This Tænia is represented in the vesicular or bladder form by the *Cysticercus fasciolaris* Rud., which inhabits the liver of Rats, Mice, Norway Rats, Voles, and Water-Rats. This Cysticercus—which is always coiled up in a cyst it has itself produced—is remarkable for its elongated form and the smallness of its vesicle. Its length varies between 3 cm. to 20 cm., and even more. The vesicle or bladder is globular or ovoïd, and is frequently no larger than a pea; it

terminates a distinctly-formed chain of segments, which are short and wide, and have not a trace of genital organs. At the anterior extremity—which is 4 mm. to 5 mm. broad—is a slit, at the bottom of which the head is invaginated. In 1844, Von Siebold saw this Cysticercus become transformed into *Tænia crassicollis* in the intestine of the Cat. According to Leuckart, all the segments disappear during this process, and the scolex is formed anew; while Baillet has demonstrated that Rats will become the hosts of *Cyst. fasciolaris*, by feeding them with the mature segments of *T. crassicollis*.

This Tænia is common in the small intestine of the Cat, and it may, when numerous, occasion serious disease. Romano has published the account of an epizoöty among Cats caused by this Tapeworm. The animals died after showing the following symptoms: gradual diminution, then complete loss of appetite; abdomen retracted; slight diarrhœa at the commencement, then constipation; abundant salivation; sometimes spasmodic contraction of the muscles of the upper lip; great prostration, and loss of sight. Some of the animals could not hear, or appeared not to hear, the voice of a person to which they were accustomed; certain of them vomited, and this seemed to give them slight but temporary relief. Nervous phenomena, epileptiform convulsions, and more frequently attacks of colic, were also remarked. A similar epizoöty prevailed among Cats in the Black Forest in 1874.

FIG. 245.—Head of the *Tænia crassicollis*; magnified fifteen diameters.

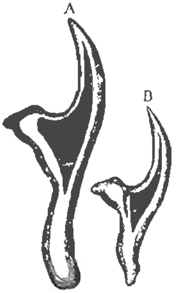

FIG. 246.—Hooks of the *Tænia crassicollis*; magnified 125 diameters.

FIG. 247.—*Cysticercus fasciolaris*. —Leuckart.

At the autopsy of the animals which had succumbed, there were found—along with Tæniæ extending from the stomach to the middle of the small intestine—evidence of chronic enteritis and a violent gastric catarrh. The hooks of the worm were deeply implanted in the mucous membrane.

Perroncito was inclined to attribute a rupture of the intestinal wall

he found in a Cat, to the action of *T. crassicollis*; and Grassi and Parona have witnessed an analogous case; while Zschokke also considered this tænia as a frequent cause of death among Cats.

The Cat contracts the *T. crassicollis* in eating Rats or Mice which harbour the *Cysticercus fasciolaris* in their liver. In Romano's observation, the Cats he alludes to had to encounter swarms of Rats, which were unusually numerous that year; and it was those which were the best 'ratters' that succumbed to the epizoöty.

Baird has described a *Tænia semiteres* from the intestine of the Cat, but it appears to be only a monstrous form of *T. crassicollis*.

2. **Dipylidium caninum** (L.). *Tænia elliptica* (Batsch).—This is a variety (*var. cati*) of the species of the Dog. It is usually smaller—10 cm. to 32 cm. long, and 3 mm. at its greatest breadth. The ova, larger than those of the *var. canis*, are 49 μ to 54 μ in breadth.

Krabbe states that, in Iceland, he has never found *D. caninum* in Cats, although it is very common in Dogs. On the other hand, in Copenhagen, Krabbe discovered *D. caninum* in a moiety of the Cats he examined, the parasite being lodged in the posterior two-thirds of the small intestine. In general, there were not more than 50, though it was not rare to count them by hundreds; on one occasion there were 500, and on another 600.

3. **Mesocestoides lineatus** (Gœze).—Baillet, who was the first to observe this Tape-worm in the Cat, gave it the name of *T. pseudo-elliptica*, just as he had designated that which he met with in the Dog as *T. pseudo-cucumerina*. These two have usually been regarded as identical, although, according to Baillet, the ova are smaller in this worm—31 μ to 36 μ. It is not rare at Toulouse; and Krabbe has seen it in more than a third of the Cats he examined in Iceland, but he never saw it in Dogs or Cats in Copenhagen. In the Cat, it sometimes measures 65 cm., and there are always several, though never more than 20.

Of these three species of Tæniæ, the only one possessing much interest—from a pathological point of view—is the *T. crassicollis*.

Bothriocephalus Felis (*Creplin*).—In 1825 Creplin found two young species of Bothriocephalus in the intestine of a Cat at Griefswald. One measured 4 mm., the other 7 mm. long. He named them *Bothriocephalus Felis*; but Diesing—without sufficient reason—classed them with *B. decipiens*, which lives in the intestine of several wild Felidæ. Ercolani described a Bothriocephalus that measured 65 mm., and Krabbe collected at Copenhagen, from the small intestine of two Cats, five specimens which measured from 15 cm. to 22 cm., and which he looked on as different from the *Bothriocephalus latus* of Man. Bruckmüller, Alessandrini, Zschokke, and Perroncito, have also collected Bothriocephalus species from the Cat; but the last of these authorities recognised a great analogy between his specimens and those found in Man. These various worms, which—for lack of sufficient studying—have all been grouped under the name of *B. Felis*, much resemble the *B. latus* in their general features, if not in their dimensions. Their ova are smaller, being no more than 50 μ to 60 μ long. No disturbance to the Cat has been ascribed to the presence of *B. Felis*.

NEMATODES.—**Ascaris mystax** (Zeder—Fig. 238).—This species presents all the characters of the Ascarid of the Dog, which is only a larger variety. This of the Cat measures 4 cm. to 6 cm. long (male), or 4 cm. to 10 cm. (female).

The *Ascaris mystax* is more especially found in young Cats, and is present in the small intestine, sometimes also in the stomach, when it may cause vomiting, though it rarely disturbs the health of its host. Krabbe has met with it in more than 50 per cent., of the Cats he examined ; in those under three years old, 17 of 19 were affected, above that age 8 of 24 ; the number of worms was usually under 10, sometimes 20 to 30, and once it was 80.

Oxyuris compar (Leidy).—The female only of this is known ; it is 8 mm. to 15 mm. long. It was found in 1856 at Philadelphia, by Leidy, in the small intestine of a Cat, along with *Tænia crassicollis*.

Anchylostomum trigonocephalum (Rud.).—Parona and Grassi have made known a pernicious anæmia which prevails among Cats in Italy, and which they attributed to a Worm they have named *Dochmius Balsami*. It plays the same part in this affection that the '*Ankylostomum duodenale*' does in miners' anæmia, and that which is ascribed to the *Anchy. trigonocephalum* in the pernicious anæmia of packs of sporting Dogs. But Railliet has been able to assure himself *de visu*, thanks to Professor Parona, that the *Dochmius Balsami* does not sensibly differ from the *Anch. trigonocephalum*. It is also probably confounded with the *Strongylus tubæformis* Zeder. It is, therefore, under the name of *Anchylostomum trigonocephalum* that the parasite which causes the pernicious anæmia of Cats should be described.

This disease is marked by slowly progressive debility ; the Cat is often ill for four months before emaciation is very noticeable. A dark-coloured diarrhœa sets in with intensity at first, then gradually diminishes ; the animal's tail is constantly soiled in consequence. Inappetence is manifested, with retching or vomiting, and death is brought about by exhaustion. In very serious cases, a fatal termination occurs after a month of diarrhœa. In others, there are alternations of aggravation and amelioration ; and frequently the existence of the malady is only recognised some months after its commencement. At times, recovery takes place after grave exacerbations.

The diagnosis is based on recognition of the preceding symptoms, and the presence in the diarrhœic products of the ova of the *Anch. trigonocephalum* ; the adult worms may also be found in these, especially if an anthelminitic has been previously administered.

With regard to prognosis, this will greatly depend on the relative quantity of ova and worms observed in the fæces.

The autopsy shows all the lesions of anæmia, and the Helminthes localized in the small intestine for a distance of 20 cm. to 60 cm. from the stomach ; they may be grouped in four or five zones, or, if they are numerous, be spread over one-half the length of the intestine. Sometimes as many as 200 or more are found. They

are floating in the intestinal fluid, or adhering to the mucous membrane, often very tenaciously. They are white, black or red, according as they are empty or full of blood; the mucous membrane is speckled with hæmorrhagic points, and the food in the colon is impregnated with blood.

The treatment should be the same as for the pernicious anæmia of Dogs, the doses of medicine being reduced to one-fourth.

Other Nematodes.—Leidy has described a *Trichosomum lineare*, seven specimens of which he met with in the small intestine of a Cat. Body filiform, and almost equally attenuated at both ends. Caudal extremity of the *female* coiled up in a spiral manner; tail curved, obtuse, and having two conical points on the ventral surface. Caudal extremity of the *male* spiral; tail long, conical, and acute; genital opening at a great distance from the end of the tail. Length of the female 7·6 mm., and male 3·8 mm.; the breadth of the female is ·35 mm., and the male ·21 mm.

Railliet states that the museum of the Alfort Veterinary School contains specimens of the *Spiroptera sanguinolenta*, labelled as from the intestine of the Cat.

In the intestine of this animal may also be found embryos of *Ollulanus tricuspis*, when the adults occupy the substance of the gastric mucous membrane.

ARTICLE VIII.—Parasites of the Intestine of the Rabbit.

COCCIDIA.—First noticed by Remak, the intestinal coccidium of the Rabbit has been refound and studied by numerous observers (Kölliker, Lieberkühn, Klebs, Vulpian, E. Neumann, Stieda, Reincke, Rivolta, Riecks, etc.). Until recently it has been regarded as a distinct species, *Coccidium perforans* (Leuckart); but the careful researches of Metzner have demonstrated its identity with *Coccidium cuniculi* (Rivolta), which is found in the Rabbit's liver.

Coccidium cuniculi, in the state of oöcyst, is usually a little smaller (25 μ to 35 μ long by 15 μ to 20 μ broad) in its intestinal habitat than in the biliary canals. It infests the epithelial cells of the villi and of Lieberkühn's glands. One cell may be invaded by one, two, or even six coccidia, in various stages of development, from the naked protoplasmic form to that of a mass surrounded by a thick shell (oöcyst). These different stages of the coccidia indicate successive auto-infestation rather than fresh invasion by germs introduced from without. After a certain time the coccidia perforate the epithelial cells and fall into the cavity of the intestine, where, according to Stieda, some of the parasites undergo certain modifications. But ulterior development takes place normally outside the intestine, in a liquid medium or in damp soil.

Intestinal coccidiosis is usually shown by chronic anæmia, wasting, and more or less diarrhœa. In grave cases with extensive infestation there is inappetence, rapid emaciation, profuse diarrhœa, and death from cachexia. The coccidia are more abundant in the intestinal than in the hepatic form, and diagnosis

can be assured by microscopical examination of the fæces, in which the coccidia are very numerous.

At the autopsy there is found catarrhal inflammation of a portion or the whole of the intestinal canal. In the large intestine, the mucous membrane is covered by a thick croupous layer, and shows some greyish, necrosed spots surrounded by a dark-red inflammatory zone. In the products of necrosis, and in the croupous layer—in the midst of particles of food, epithelial cells and pus globules — are seen numerous coccidia. Sometimes, in benign cases, there are whitish spots, punctiform or from 2 mm. to 6 mm. in diameter, which correspond to masses of coccidia. The glands of Lieberkühn are sometimes stuffed with them. Klebs and Vinogradoff have found coccidia in the submucous connective tissue, and Riencke some young forms in the mesenteric glands. Treatment to be successful must be preventive. Diagnosis being established, it is advisable to sacrifice without delay the affected animals, and to carefully disinfect the hutches which they have occupied. The healthy Rabbits should be placed in clean hutches, and supplied with dry food and pure water.

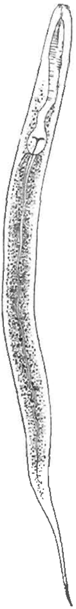

FIG. 248.—Recently hatched larva of the *Strongylus strigosus*; magnified 200 diameters.—Railliet.

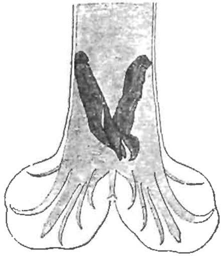

FIG. 249.—Caudal extremity of the male *Strongylus retortæformis*; magnified 150 diameters.—Railliet.

INFUSORIA.—Davaine has described an infusorian—*Lamblia intestinalis* (R. Bl.)—which he found in abundance in mucus from the duodenum of a rabbit recently killed and still quite warm.

Cestodes.—Cestodes in the small intestine of the domesticated Rabbit are rare. Those which are sometimes found appear to belong to the same species—*Cittotænia ctenoides* (Raill.). The Cittotæniæ are anoplocephalines which live in rodents, and have, like the *Moniezia* of ruminants, two genital pores in each segment.

Cittotænia ctenoides may attain 80 cm. in length. Its head is small (500 μ broad), with flat suckers; the neck, as broad as the head, becomes constricted where it continues the chain. The segments—always broader than long—may attain 1 cm. in breadth. The genital pores are in the posterior fourth of the border of the segment.

At present nothing is known as to the origin or the possible pathological effects of this cestode.

ACANTHOCEPHALA.—Bellingham has noticed an Echinorhynchus (*Echinorhynchus cuniculis*, Bell.)—but without giving a description of it—which he found in the small intestine of the domesticated Rabbit.

NEMATODES.—**Oxyuris ambigua** (Rud., *Passalurus ambiguus* Duj.).—A white fusiform worm, the *male* of which is 3 mm. to 5 mm. long, and the *female* 8 mm. to 11 mm.; the body in both sexes terminates in a subulated or suddenly tapering tail ·20 mm. in length. It infests the large intestine and cæcum of the Rabbit and Hare. At Vienne, according to Dujardin, it is found in 12 of every 125 animals.

Strongylus strigosus (Duj.).—This strongyle has only been noted as inhabiting the cæcum and colon of the wild Rabbit. Railliet has found it at Alfort in the stomach of the domesticated Rabbit, and Perroncito has observed the same at Turin. It must not be mistaken for *Str. retortæformis* Zeder, which has thick, short and twisted spicules, and infests the small intestine of the Hare and wild Rabbit. Railliet has, however, also found this species in the small intestine of the domesticated Rabbit.

Trichocephalus unguiculatus (Rud.).—This species is particularly characterized by the tenuity of the spicule and its sheath, which is smooth. The male and female are 3 cm. to 4 cm. long. It is met with in the large intestine, and more especially in the cæcum, of both the wild and domesticated Rabbit, and the Hare (Schneider).

Long Strongyloid of the Rabbit (*Strongyloides longus*, Grassi and Segri).—This is a species observed by Grassi and Perroncito, in the posterior moiety of the duedonum, in the jejunum, and sometimes in the first portion of the ileum. The female only appears to be known. It is ·37 mm. long on the average, the œsophagus occupying nearly one-fifth. This œsophagus is triquetrous, and gradually expands posteriorly; it has no chitinous armature. Ovary double; vulva situated towards the posterior third of the body, and surrounded by papillæ. Eggs ovoïd, 40 μ long, and 20 μ wide.

The four species of Nematodes we have mentioned have not, up to the present time, been considered as playing any pathogenic part in the domesticated Rabbit.

ARTICLE IX.—Parasites of the Stomach and Intestines of the Elephant.

Steel mentions that 'round worms' are found burrowing in the coats of the stomach of the Elephant, and there form for themselves 'abodes,' which occur as tumours, having burrowing channels in the mucous membrane, the larger and smaller of these being formed by different species. No practical

importance can yet be attributed to these parasites. One round worm occurs in both stomach and intestine, and three others have been found in the latter; they vary in length from 9 lines to 3 inches, and an even larger form is said to be found occasionally in the bile-ducts. There is no evidence that they cause inconvenience.

Three species of Amphistomum are found in the intestines, but only one —*Amphistomum Hawkesii* Cobbold—is of any importance. They give rise to a diarrhœa, known in India as 'Lungen,' which is the most frequent disease of Government Elephants—proving fatal in some cases, as when the animals are young, or are improperly fed and tended. Death results from exhaustion, which is caused by the drain on the system effected by these animal parasites in two ways; firstly, by irritation causing profuse diarrhœa; and secondly, in all probability, by direct removal of blood from the mucous membrane of the intestine, to which they adhere with the greatest tenacity, by means of their suckers. Of course, they must be present in very large numbers to produce such serious effects, which are all the more easily and quickly induced if the Elephant they invade is already weakened. Almost every Government Elephant in India is infested with some of these Amphistomes, which in some instances become so numerous, and cause so much irritation, that purging sets in, and they are got rid of if the animal is sufficiently strong to withstand their attacks. As parasites of a closely allied species occasionally cause the death of Horses in India, Cobbold was inclined to believe that the Elephant Amphistome is derived from the Horse. The symptoms are those of ordinary diarrhœa of a severe and persistent character, preceded by a depraved appetite and a tendency to eat earth, which renders the fæces muddy; while the dejections contain—generally in enormous numbers—small translucent bodies of a pink colour, resembling soaked barley-grains, measuring three-eighths of an inch long, by one-fourth of an inch broad. Careful examination of these will lead to their being identified as Amphistomes—and especially the presence of a circular sucker at each extremity of their elongated bodies. After a time, œdematous swellings appear about the head and shoulders, and the animal dies from exhaustion.

If an autopsy is made immediately after death, the Amphistomes are often found in myriads, adhering by means of their suckers to the mucous membrane of the large intestine, some being also free in the intestinal canal. The intestine exhibits indications of irritation, especially in the form of gelatinous effusion between the tunics; and there are generally other parasites associated with these. The other organs of the body are anæmic, and more or less dropsical, while the blood is very deficient in colour. Infestation probably takes place by means of green forage.

An outbreak of this parasitism occurred among the Elephants of a London circus in 1878, and caused much loss (G. Fleming).

B.—DOMESTICATED BIRDS.

ARTICLE I.—Parasites of the Intestine of Poultry.

INFUSORIA.—Eberth has remarked in the intestines of several Birds, and notably in the Fowl, an Infusorian in the glands of Lieberkühn that Künstler places in the genus *Trichomonas*—*Tr. Eberthi* Sav. Kent. It is remarkable for the presence of a very salient, plicated, undulating membrane placed along the body.

COCCIDIA.—The intestinal coccidium of the Fowl, *Coccidium avium* (Silvestrini and Rivolta), *C. tenellum* (Raill. and Lucet), first seen by Silvestrini and Rivolta, then by Perroncito, and connected provisionally with *C. perforans*, represents a distinct species which Railliet and Lucet have carefully studied.

This coccidium is usually ellipsoidal (the two poles having the same breadth), with a thin shell, and, in the state of oöcyst, measures from 24 μ to 36 μ long by 12 μ to 22 μ broad. It develops after the manner of *Coccidium cuniculi*.

Intestinal coccidiosis of the Fowl often occurs as an epizoötic, and attacks nearly as many adults as young chickens. The affected birds are unthrifty, lose appetite, and become emaciated. Constipation is followed by profuse diarrhœa, which is sometimes sanguinolent or brick-red, more often whitish, then greenish. Those attacked become apathetic and isolate themselves, the comb assumes a bluish tint, and there is free salivation. Death takes place in two or three days, though sometimes, particularly in adults, the disease may continue for a fortnight, and it may even pass to the chronic state; the birds are then transformed into veritable skeletons, and eventually succumb to marasmus. In very young subjects the course of the malady is very rapid. The mortality reaches 60 to 70 per cent. of the affected. Diagnosis can be assured by the discovery of coccidia in the fæcal matters.

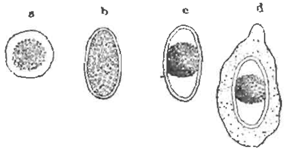

FIG. 250.—*Coccidium avium* of the Fowl's intestine.—After Perroncito.

a, *b*, Coccidia extracted from the epithelial cells of the intestine, and representing the first phases of development; *c*, encysted adult coccidium, found free in the intestine; *d*, adult coccidium encysted in an enlarged and deformed epithelial cell.

The lesions are usually localized in the small intestine, and particularly in the duodenum; the mucosa is dark red, swollen, and strewn with spots or irregular whitish streaks formed by masses of coccidia. The alimentary matters, not very abundant, contain a large quantity of encysted coccidia, free or still enclosed in the epithelial cells; the villi are injected, and more or less denuded of their epithelium.

In certain cases the lesions are exclusively limited to the cæca. The contents of the cæca, very fluid, offensive, and brick-red, include a few coccidia, some altered epithelial cells, blood corpuscles, and many globules of fat.

In the state of oöcyst more or less advanced, the coccidia of the Fowl may exist from one year to another in the damp soil of the poultry-yard. They are ingested by the birds with their food and water. The most severe epizoötics occur in summer in artificial yards, and particularly where air and light are insufficient. It is possible that the disease may be introduced by eggs used in breeding, for Eckhardt has found coccidia on the shell and in the white of the eggs from Fowls attacked with coccidiosis.

CESTODES.—Nine species of Cestodes—eight Tæniæ and one Bothriocephalus—are found in the intestine of the Fowl. But the

numerous forms of Tape-worms mentioned as infesting this Bird are difficult to distinguish from one another, while the majority have been incompletely described; besides, the hooks with which the head is armed are usually very temporary, and after they are shed the physiognomy of the scolex is so modified that the species can scarcely be distinguished; and, finally, many Tæniæ are so seldom met with, that there is little opportunity for establishing their natural history on a solid basis. In certain cases the intestine contains them in such numbers, and so many Fowls are infested, that there prevails a kind of epizoötic tæniasis.

1. *Choantænia infundibuliformis* Gœze.—Length 20 mm. to 130 mm., exceptionally 230 mm.; breadth 1 mm. to 2 mm. Head oval, slightly flattened, and ·50 mm. long; long rostellum, retractile or protractile, cylindrical or hemispherical, and bearing a single crown of 16 to 20 hooks, according to Krabbe—30 according to other authorities, which are 20 μ to 27 μ long; suckers small and neck very short. First segments very short, and the succeeding ones infundibuliform, the anterior border being narrower than the posterior. Genital pores single, and irregularly alternated. These worms are often present in hundreds in the intestine of the Fowl. Grassi and Rovelli state that the Cysticercus of this Tænia has, for its intermediate host, the house-fly.

2. *Dicranotænia sphenoides* (Raill.).—Length 2 mm., breadth 1 mm. Rostellum provided with 12 hooks, 32 μ long. Suckers oval and elongated. Strobila cuneiform, comprising 12 segments, which increase in breadth from the first to the last. Grassi and Rovelli assert that this Tænia has for its intermediate host an Earthworm, the *Allobophora fœtida* (Eisen).

3. *Davainea proglottina* (Dav.).—Length ·5 mm. to 1·55 mm., breadth from ·2 mm. to ·5 mm. Head quadrangular, slightly rounded in front, from ·15 mm. to ·20 mm., furnished with a convex rostrum, retractile, carrying at its base a crown of about eighty hooks 7 μ long; suckers small, armed with spines 6 μ long. The chain, composed of 2 to 5 segments, gradually increases in length and breadth; genital pores alternate, situated at one of the anterior angles of the segments. Ova very large—50 μ—and each contains a very active embryo. The segments separate as soon as they are formed; they live and are developed when free, acquiring double the total length of the Tænia. When fully extended they are 1·8 mm. long, and only one-half this measurement in the state of retraction. They move about in a very lively manner. Davaine found these proglottides—which had been already seen by Dujardin—in considerable numbers in the duodenum of all the Fowls he examined at Saint-Amand, Nord, in 1885. He obtained a very small number of heads by scraping the mucous membrane of the duodenum. According to Grassi and Rovelli, this Tænia lives as a Cysticercus in several species of Limax—*L. cinerus*, *L. agrestis*, *L. variegatus*. In less than twenty days, the ova are transformed into cystic larvæ in the organs of these molluscs. Fowls readily eat the molluscs, and become infested with this tapeworm, which attains the adult stage in about eight days.

4. *Davainea cesticillus* Molin (*T. infundibuliformis* Duj.).—Length 9 mm. to 45 mm. (Molin), or 110 mm. (Krabbe); breadth 1 mm. to 2 mm. Head pyriform; rostrum scarcely salient, depressed, discoïd, and surrounded at its base by a ring (which is unarmed according to Molin), provided with a double crown of 208 hooks, 7 μ to 9 μ long and very temporary. Neck null. First segments very short, and broader than the head; the last are nearly as long as they are broad. Genital pores single, and irregularly alternate. A common species.

5. *Davainea echinobothrida* Mégnin.—Length 50 mm. to 100 mm., breadth 2 mm. Rostrum replaced by an infundibulum armed with a double crown of about 100 hooks. Suckers armed with crowns of rose-like thorns, those of the middle rows being the largest. No neck. Genital orifices irregularly alternate.

6. *Davainea tetragona* (Molin).—Length 12 mm. to 90 mm. (Molin), 200 mm. (Piana), 250 mm. (Krabbe); breadth 1·6 mm. to 3 mm. Head small, tetragonal; rostrum armed with a double crown of about 200 hooks 6 μ long; suckers furnished with seven to eight rows of unequal hooks. Neck long, first segments very short, the following segments subquadrangular and imbricated, genital pores unilateral on the middle of the border of each segment.

7. *T.* (?) *exilis* Duj.—Length 100 mm., breadth 1 mm. to 2 mm. Head tetragonous and ·60 mm. broad. Rostellum short, depressed, and armed with a single crown of 60 hooks, 8 μ long. Suckers orbicular; neck distinct and 5 mm. long. Segments wider than they are long, and the anterior border narrower than the posterior, giving the strobila a saw-like appearance. Genital pores unilateral.

8. *T.* (?) *malleus* Gœze.—Length 40 mm. to 200 mm., breadth 4 mm. to 5 mm. Head very small and ·12 mm. broad. Rostellum short, slender, and armed with 12 hooks, 17 μ long. Suckers ·05 broad. Neck short, 80 μ broad, followed by a transverse dilatation, formed of very numerous but little distinct articles. Ova collected in files or series (Dujardin). Found by Creplin in the Cock; more frequent in the Duck.

9. *Bothriotænia longicollis* Molin. — Length 18 mm. to 27 mm., breadth 4 mm. Head small and claviform. Suckers in the form of oval, lateral slits. Neck long and slender; body tænioïd, and furrowed by two longitudinal grooves. First segments very short, the succeeding ones being almost quadrangular, and the last elliptical, transversely elongated, and having rounded borders. Genital pores unilateral, situated at the middle of the border of each segment.

This species was found in Paris by Molin, in the small intestine of a Fowl.

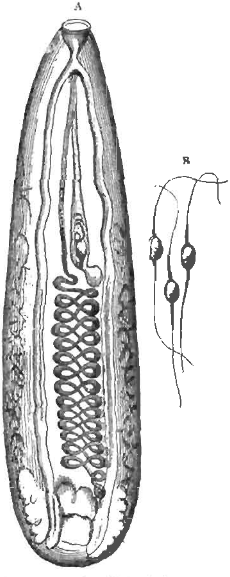

FIG. 251.—A, *Notocotyle verrucosum*, young specimen; magnified forty diameters. B, three ova from the same; magnified 215 diameters.—Dujardin.

According to Nessl and Lucet, the young Fowls which harbour numerous Tæniæ lose their appetite, become emaciated, dull and feeble, isolate themselves, and hold their head under the wing. Other authorities have observed diarrhœa, sometimes epileptiform attacks, stiffness in movement, and the legs straddling.

The only indubitable sign is the presence of proglottides in the fæces.

With regard to the treatment of tæniasis in Fowls, the best method is to mix powder of the bark of pomegranate-root—a teaspoonful for every fifty head—in their food.

TREMATODES.—1. *Notocotyle verrucosum* Frölich.—Body white or reddish, 2 mm. to 6 mm. long, and ·7 mm. to 1·5 mm. broad; oblong-oval, very

depressed, narrow in front, rounded behind; 36 to 47 round, reddish papillæ, arranged in three rows on the ventral surface—sometimes absent, according to Dujardin—and constituted, as stated by Wedl, by the groups of the terminal vesicles of the vitelline sacs, which become prominent. Penis studded with small spines. Vulva situated behind, and at the base of the receptacle for the penis. Ova of special form, somewhat reddish, elliptical, 23 μ long and 11 μ broad, and furnished at each end with a filiform appendage 160 μ long. Found by Von Siebold in the cæcal intestine of the Fowl; though it is more frequent in the Duck.

2. *Distomum oxycephalum* Rud.—Body oval and depressed, 6 mm. to 8 mm. long, and ·3 mm. to 2 mm. broad. Oral sucker unarmed; ventral sucker very large. Anterior part attenuated, and provided with small spines. Dujardin and Von Linstow consider this species as a mere variety of the *D. echinatum*, of which the hooks are little visible or are detached. Rare in the Fowl; more frequent in the Duck.

3. *Distomum dilatatum* Fischer de Waldheim.—Body elongated, flattened, rounded behind, from 4 mm. to 8 mm. long, and 2 mm. broad. The anterior part is attenuated into a kind of neck, which presents in its middle a dilatation 1·2 mm. long. Found in the intestine. Rare. It is probably the *D. echinatum* (Zeder).

4. *Distomum lineare* Rud.—Body reddish, linear, flat, obtuse behind, 10 mm. to 15 mm. long, and 1·5 mm. broad. Oral sucker surrounded by six small papillæ. Found in the rectum. Rare.

5. *Distomum armatum* Molin.—Body linear, flat, rounded behind, inferior surface a little concave, and covered with small, closely-set spines which are absent behind; prolonged in front by a conical neck carrying semi-lunar head furnished with two rows of spines; oral sucker oval; the ventral sucker much larger, and situated at the base of the neck. Total length 8 mm., width 1 mm. Found by Molin in Italy, in the cæca and rectum of a Fowl. Probably it is the *D. echinatum*.

6. *Cephalogonimus ovatus* Rud.—Body flattened, oval, narrower in front, whitish, speckled with black, 4 mm. to 7 mm. long, and from 2·25 mm. to 4 mm. broad behind. Oral sucker terminal, orbicular, prominent, and from ·4 mm. to ·6 mm. wide; the ventral sucker is double this in size. The integument is studded with hooks pointing backwards, very close together in the anterior region, deciduous, and only visible in very young specimens.

It is found in the sac of Fabricius of numerous Birds, among which is the Fowl, but only when it is young, as this bursa disappears with age and the advent of the generative functions (Retterer).

7. *Mesogonimus dimorphus* Wagener.—Body flat, about 7·5 mm. long, and 1·5 mm. broad in front, 2 mm. behind; white except on the middle third, at the posterior sucker, where it has a dark tint from the presence of eggs in the oviduct. Orbicular suckers larger, the anterior a little more so than the posterior. Testicles rounded, and situated in the posterior part of the body, one behind the other. The genital openings are situated on the ventral surface, behind the posterior sucker and in front of the anterior testicle. The vitellogenes are lateral, occupying the anterior two-thirds. Ovary a little to the right, between the two testicles. Eggs ovoïd, 27 μ long, and 14 μ broad. Found for the first time by Wagener, then by Sonsino, who has given a good description of it. It inhabits the cæca of the Fowl.

All these species of Trematodes are without importance from a pathological point of view.

NEMATODES. — 1. *Heterakis papillosa* Bloch. — Mouth surrounded by three lips. Pharyngeal bulb not distinct. *Male* 8 mm. to 9 mm. long; two unequal spicules; pre-anal sucker encircled by a salient vesicular ring; posterior part fine and subulated. *Female* 11 mm. to 15 mm., and gradually attenuated towards the posterior part. A common species: of 190 Fowls or pullets, Dujardin at Rennes found it in 107, and exclusively in the cæca—sometimes in prodigious quantity during various seasons. At Vienne it has been met with in 41 of 127 Fowls.

2. *Heterakis differens* Sonsino.—A slightly larger species than the preceding. The mouth has no apparent lips. Pharyngeal bulb distinct. Two equal spicules, accompanied by an accessory piece; sucker neither salient nor winged. Posterior extremity of the female sharply acuminated. Found by Sonsino in the posterior portions of the Fowl's intestine.

3. *Heterakis perspicillum* Rud.—Body of a dirty-yellow colour, 3 cm. to 8 cm. long in the *male*, and 7 cm. to 12 cm. in the *female*. The tail ends in a sharp mucron. Infests the small intestine. At Rennes, Dujardin found it in only thirty of 195 Fowls and pullets. It was not met with at Vienne in 127 Fowls examined.

4. *Heterakis compressa* Schn. — *Male* 5 cm. long; *female* 9 cm. long. A species found by Schomburg in the intestine of the Fowl in South Australia. Finally, we have already mentioned the larval Nematodes found by Badoky, encysted in the walls of the stomach and intestine.

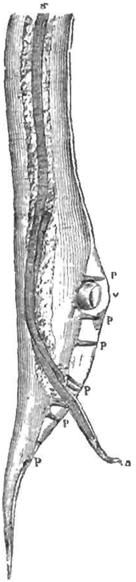

FIG. 252. — Caudal extremity of the male *Heterakis papillosa* of the Fowl.

s', Left short spicule; *s'*, right long spicule; *v*, sucker; *pp*, papillæ.

Baronio has described an epizoötic malady which prevailed among Fowls and other domesticated Birds in Lombardy, during the summer of 1789, and which he attributed to worms in the intestines. From the dimensions he gives, these worms might be the *Heterakis perspicillum*; but notwithstanding their considerable numbers in the intestines and the sometimes salutary effects of vermifuges, judging from the symptoms and the lesions it might be affirmed that the helminthiasis was accessory, and that the cause of the mortality was probably nothing else than Fowl-cholera.

This is not the case, however, with the observations of Blavette and Rossignol. Death here appeared to be due to the accumulation of the *Heterakis perspicillum* in the intestine. In the first case, there were about thirty in each Fowl that had died; and in the second they formed one or two pellets the size of a pigeon's egg, situated in the duodenum, which they obstructed. Some of the worms were isolated, and extended throughout the length of the small intestine. But what still leaves doubts—especially in Rossignol's case—is the sudden appearance of the disease, its rapid progress, and the mortality attending the epizoöty, which had neither the physiognomy nor the symptoms of a verminous affection.

Mégnin asserts that helminthiasis due to the *Heterakis perspicillum* is manifested by diminution of appetite, emaciation, indifference, somnolency, with sudden starts of wakefulness, and diarrhœa. He recommends mixing santonica with the

food given to the Fowls, or incorporating it in powder in a cake, the dose being 4 to 5 grammes for ten Birds.

In Blavette's observation, the good effects of anthelmintic treatment are demonstrative. Following Baronio's example, he employed a mixture of equal parts of the root of male fern, tansy and savory, of which he made a decoction—about 300 grammes to $1\frac{1}{2}$ litres of water; the resulting fluid was mixed with flour, and of this pills were made, which were forcibly administered to the diseased Birds.

5. *Trichosomum retusum* Raill.—*Male*, 13 mm., *female*, 19 mm. long. Posterior extremity of the body rounded, and blunt in the female. The sheath of the spicule in the male is smooth.

6. *Trichosomum annulatum* Molin.—Length of the *male*, 15 mm., of the *female* 80 mm. Body white, capillary, very attenuated at its anterior extremity, and elegantly marked with close annular stripes.

7. *Trichosomum collare* Linstow.—Length of the *male*, 8 mm. to 10 mm., of the *female*, 9 mm. to 12 mm. Cephalic extremity in the form of a truncated cone. The sheath of the spicule of the male is covered with fine bristles. Found by Von Linstow in great quantities in the intestine of a Fowl.

The Trichosomes are not frequent in the Fowls' intestine. In more than 180 Birds, Dujardin only found them in eight. So far as pathology is concerned, these parasites possess no interest. They occupy various portions of the intestines, but more especially the cæca and colon; though Zürn indicates the *Tr. annulatum* as having been found by Molin beneath the œsophageal epithelium of the Fowl.

8. *Dispharagus spiralis* Molin.—This has been already noted as parasitic in the œsophagus of the Fowl. It has been met with in the intestine of this bird by Fedschenko, in Turkestan (Von Linstow).

Lucet has observed a verminous enteritis in poultry-yards, due to the association of various species of Helminthes. The affection made slow progress, and the Fowls attacked preserved their appetite, but lost condition, and became dull and indifferent; later, the feathers lost their lustre and became erect; while the wings were drooping and the movements languid. A fœtid diarrhœa set in, wasting became more marked, and the appetite was diminished; soon the creatures remained immovable and huddled up, with their eyes half closed; the comb and mucous membrane lost their colour, the temperature was below normal, the appetite disappeared, and the feet were swollen. These Fowls often yawned, and their torpor and anæmia were extreme; death ensued in a tranquil manner in about one or two months. At the autopsy, in addition to the emaciation, there were observed the lesions of a chronic diarrhœic enteritis, and the following Helminthes—*Davainea proglottina*, *Ch. infundibuliformis*, *D. cesticillus*, *Heterakis papillosa*, *H. inflexa*, and *Trichosomum collare*. The *D. proglottina* was the principal cause of the malady, and in each case was found in thousands. The *Heterakis* species were less constant, though they had taken a good share in the development of the affection. The successful treatment consisted in the intermittent employment of calomel in doses of 1 to 2 centigrammes, and the heads of santonica, artemisia vulgaris, and wormwood, mixed with the ordinary grain on which they were fed. The hen-roosts were scrupulously cleansed.

ARTICLE II.—**Parasites of the Intestines of the Turkey, Guinea-fowl, Peacock, and Pheasant.**

TURKEY.—The intestinal parasites of the Turkey are Protozoa and Worms.

PROTOZOA.—The *Coccidium avium*, which determines the epizoötic Coccidiosis of Fowls has been observed by Eckhardt in similar conditions in Turkeys. The disease almost exclusively attacks young Turkeys, and its symptoms and effects are very little different from those seen in Coccidiosis of Poultry. It is perhaps the same affection of young Turkeys as that studied and described, in the United States, under the name of 'Infectious entero-hepatitis,' by H. Smith, who attributed the malady to an amœba (*A. meleagridis*).

Lucet, who studied the same disease in France, named it 'Peri-typhlo-hepatitis.' He states that it affects nearly exclusively Turkeys of two to three months old. It pursues a rapid course, and proves fatal in from 80 to 90 per cent. of the cases.

Helminthes.—Intestinal worms are not common in the Turkey. They are a Tænia, a Mesogonimus, and two species of Heterakis.

The Tape-worm (*T. cantaniana* Pol.) was found by Poloni. It is 14 mm. long. Its globular head, furnished with very large suckers, is described as unarmed, perhaps because of the deciduousness of the hooks. There is no neck, and the first segments are campaniform, the succeeding ones being trapezoid.

Mesogonimus dimorphus Wagener.—This parasite of the Fowl has been found once in a young Turkey by Sonsino. The two species of Heterakis (*H. papillosa* and *H. perspicillum*) are also found in the Fowl. They are seldom met with.

The only intestinal parasite of the **Guinea-fowl** is the *Heterakis papillosa*, found in the Vienne Museum in 6 of 12 Birds.

It is the same with regard to the **Peacock**, in which this parasite has been found in 9 of 17 Birds at the Vienne Museum.

COMMON PHEASANT.—The intestinal parasitism of the Pheasant comprises a Coccidiosis and Helminthiases.

COCCIDIOSIS.—McFadyean in England and Sjöbring in Sweden have each observed in young Pheasants an epizoötic of intestinal Coccidiosis which appears to be connected with *Coccidium avium*. The symptoms are analogous to those of intestinal Coccidiosis of the Fowl; yet the enteritis is not hæmorrhagic. The coccidia mostly are in the swarming stage (Merozoites); the oöcysts measure 28 μ by 16 μ. The parasites are found in the epithelial cells, and more particularly in those of Lieberkühn's glands. Referring to an outbreak of intestinal coccidiosis in young Pheasants in 1893, McFadyean states:

In all the cases the coccidia had penetrated in great numbers into the secretory glands of the intestine, and had in large measure destroyed the epithelial cells which line these glands and the inner surface of the bowel. The chief symptom of the disease is diarrhœa, and since the parasites are passed out with the fæces, the ground soon becomes most seriously contaminated, and the disease increases at an alarming rate. Apart from the inherent difficulty of applying medicinal treatment to young pheasants, there is but small hope of effecting a cure in this condition, because the bowel is already largely invaded by the parasites before any symptoms are exhibited. More trust must be placed in preventive measures, which should be based on the fact that the disease is spread by the fæces of affected birds. The providing of fresh clean ground is, therefore, essential.

HELMINTHIASES.—The common Pheasant harbours in its intestine the *Heterakis papillosa*, the *Trichosomum retusum*, the *Choantænia infundibuliformis*, and the *T. cantaniana*. Of these, the first three have been already met with in the Fowl, the last in the Turkey. In addition to these, Von Linstow has described another species (*Davainea Friedbergeri*), probably the same that Mégnin has named *T. cesticillus*—var. *Phasianorum*. The genital pores are unilateral.

The Tæniadæ are sometimes so numerous in the intestine of the Pheasant, that they cause a real verminous enteritis, which is often fatal. Friedberger and Mégnin have drawn attention to this malady, which may prevail in an epizoötic form, more especially attacking young Birds. There is nothing particular in the symptoms, which are chiefly those of digestive or reflex disturbance common to all the intestinal Helminthiases. In several Pheasants, Mégnin has found portions of the intestine literally crammed with masses of Tæniæ, each usually composed of 15 to 20 complete individuals.

This authority has recommended treating the diseased Pheasants with kamala, mixed into a paste with hard-boiled eggs and bread, which should be given concurrently with ants' eggs. Zürn advises the employment of freshly powdered areca-nut, in doses of 2 to 3 grammes, and pumpkin-seeds.

Mégnin relates that he has witnessed an outbreak of verminous enteritis caused by the *Heterakis vesicularis*. It manifested itself by the same symptoms as that of Fowls—due to the *Heterakis perspicillum*, and should be submitted to the same treatment.

ARTICLE III.—Parasites of the Intestine of the Pigeon.

INFUSORIA.—At the autopsy of four Pigeons, Rivolta found in the small intestine a considerable number of very mobile Infusoria—the *Trichomonas columbæ* Raill. They were 6 μ to 7 μ long, and nearly 3 μ broad; were pale, oval, semilunar or constricted in their middle, more obtuse at one end than the other, and furnished with four flagella, one or two of the longest of these being situated at one end of the body. There were, besides, numerous yellow Psorospermiæ. The mucous membrane was inflamed. Rivolta attributed the death of the Pigeons to the action of these parasites.

COCCIDIA.—Intestinal Coccidiosis of the Pigeon has been observed in Italy by Rivolta and Delprato, and at Weimar by L. Pfeiffer. It attacks more particularly young Pigeons, which contract the disease in the nest from their parents. The coccidium of the Pigeon measures 18 μ long by 15 μ broad. Labbe has named it *Coccidium Pfeifferi*; probably it is only a variety of *Coccidium avium*.

CESTODES.—*Davainea crassula* Rud. Length 300 mm. to 400 mm., breadth 4 mm. Head oval; rostellum obtuse, rounded at the summit, and armed with a double crown of about 60 hooks from 10 μ to 11 μ long. Neck long and slender. First segments very short, the succeeding ones being always short, but with expanded borders; the last nearly infundibuliform. Genital pores unilateral. Ova very large, ovoid, 28 μ long, and arranged in groups. A rare species, found first in Brazil by Olfers, in a Pigeon brought from the coast of Africa; seen at Rouen by Clouet.

TREMATODES.—At the autopsy of a six weeks' old Pigeon, Mazzanti found in its small intestine a certain number of Distomes in the midst of a sanguinolent fluid, and at this spot the mucous membrane was congested and of a dark-red tint. He named this parasite *Distomum columbæ*. From the description of it, it appears to be identical with *Mesogonimus dimorphus* of the Fowl's intestine.

NEMATODES.—*Heterakis maculosa* Rud. (*H. columbæ* Gmelin).—Body white, somewhat translucid, cylindrical, and attenuated at both ends. Head with three almost equal-sized lips. *Male* 16 mm. to 25 mm. long; tail straight, conical, somewhat acute and mucronated; sucker round; ten papillæ on each side; two long spicules. *Female* 20 mm. to 35 mm. long; straight, conical or conoïd mucronated tail; vulva placed in the middle of the length of the body, which is often distended by eggs. Internal vesicles, the nature of which is not well understood, are seen through the transparent walls like so many spots. Ova 80 μ to 90 μ long, and 40 μ to 50 μ broad.

This worm is often met with in enormous quantities in the intestine of Pigeons, sometimes to such a degree as to prevent their being reared. It is not rare to find 400 to 500 in the intestine of one Bird; so that it is easy to understand the amount of digestive derangement that may result. Unterberger was one of the first to direct attention to the noxiousness of this parasite. Independently of the ova of the Heterakis—which the microscope reveals in innumerable masses in the fæces—the malady is characterized by a group of symptoms, of which the principal are torpidity, loss of appetite, periodic diarrhœa, and at last marked wasting, particularly of the pectoral muscles. Death usually occurs at this period, after general exhaustion and convulsions. At the autopsy, the worms are found closely packed together, and lying in the long axis of the intestine; the mucous membrane is distended in patches more or less large and numerous, gorged with blood, softened or ulcerated, and covered with thick mucus.

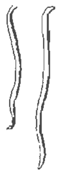

FIG. 253.—*Heterakis maculosa* of the Pigeon; natural size.

A, Male; B, female.

In about 7 grammes of fæces passed in twenty-four hours by a diseased Pigeon, there were on the average—according to Unterberger—12,000 eggs of the Heterakis. This authority placed some of these eggs on damp blotting-paper in a flask, and watched their evolution; the embryos were well formed in about 17 days. These ova were then given to perfectly healthy Pigeons, and in about three weeks the ova were transformed into adult species of *H. maculosa*, the eggs of which were discovered in the fæces. When, on the other hand, healthy Pigeons were given the ova immediately after their expulsion with the fæces, or their discharge from the oviducts, they did not develop, and were passed with the excrements intact or slightly digested. The evolution of the parasite, therefore, can only take place beyond the intestine, without the necessity, however, of an intermediate host. Infestation takes place from Pigeon to

Pigeon, through the medium of the food soiled by the excrements of the diseased.

In order to prevent the extension of this helminthiasis, the *healthy should be rigorously separated from the diseased Pigeons* : the fæces should be frequently examined by means of the microscope, so as to ascertain the condition of the Birds with regard to infestation ; the places occupied by them ought to be kept scrupulously clean, the walls, floors, ceilings, perches, nests, etc., being frequently disinfected. The grain upon which they are fed should not be scattered over the ground, but placed in proper receptacles into which the fæces are not likely to be dropped. It is well to mix aniseed, salt, and other substances appetizing for Pigeons, and also coarsely powdered areca-nut, with this grain.

With regard to treatment, in benignant cases each diseased Pigeon should receive 6 centigrammes of calomel worked up with soft bread, or made into pills with butter. In more serious cases, recourse may be had to powdered areca-nut in 1 gramme doses, *administered in the same manner (Zürn). Pelletan recommends* the vermifuge biscuits given to children, the Birds being very fond of them ; two days of this treatment are said to kill the worms. A more practical course which he advises, is to distribute among them peas which have been macerated for some hours in a cold *decoction of wormwood. The treatment* employed by Blavette for the helminthiasis of Fowls may also be adopted, the dose being reduced to one-half.

Strongylus quadriradiatus (Stevenson).—Body filiform, red (from the blood which fills the intestine), male 9 mm. to 12 mm. long, female 18 mm. to 24 mm. long. Cephalic extremity enveloped by a vesicular swelling of the cuticle. The male has a bilobate caudal pouch ; spicules terminate by three branches accompanied by a single piece in the form of a four-rayed star, which furnishes a ring of support.

Found by Stevenson at Washington. This strongyle, when present in large numbers in the intestine of the Pigeon, produces grave disorders : bacterial infection, catarrh, and profuse diarrhœa.

Trichosomum tenuissimum Dies. (*Tr. columbæ* Rud., *Calodium tenue* Duj.). —*Male* 10 mm. long, the slender part being 4·7 mm. ; tail obliquely truncated ; sheath of the spicule regularly ridged transversely. *Female* 18 mm. long, the anterior portion being 7 mm. ; vulva provided with a salient membranous appendix. A frequent and abundant species in the small intestine. Pauly and Zürn state that it often determines an intense intestinal catarrh, which leads to anæmia and consumption.

Filaria clava Weld.—This is stated by Von Linstow to inhabit the intestine of the Pigeon. We only know it as a parasite of the connective tissue.

ARTICLE IV.—Parasites of the Intestine of the Duck.

INFUSORIA.—Davaine has found in the cæcum of a Duck examined immediately after death, flagellated Infusoria which he named *Monas (Monocermonas) anatis*. The body is oval, oblong, transparent, 8 μ long, and 4 μ broad, and has an anterior flagellum which is flexible throughout its length, and is longer than the body. This is perhaps only the *Trichomonas Eberthi*, found by Eberth in the Fowl, and also in the glands of Lieberkühn of the Duck.

COCCIDIA.—Zürn has described a Coccidian enteritis of Ducks. It is characterized by marked feebleness and wasting, followed by profuse diarrhœa which soon causes death. Railliet and Lucet have found in Ducks, which during life had never shown any symptoms of disease, intestinal nodules containing coccidia identical in appearance with those of the Fowl (*C. avium*).

CESTODES.—The domestic Duck harbours in its intestine eight species of Tæniadæ. They are much more frequent in it than in the Fowl, and their larval phase is probably passed in aquatic Invertebrata—no doubt Molluscs, the Duck being more than any of the other domesticated Birds exposed to infestation.

1. *Choantænia infundibuliformis* Gœze.—Rudolphi and Bellingham found this parasite in the domestic Duck in December. This was probably an error of identification.

2. *Tænia malleus* Gœze.—This is more frequent in the Duck than the Fowl.

3. *Drepanidotænia anatina* Krabbe.—This is 300 mm. long, and 3 mm. broad. The rostellum has a single crown of 10 hooks, 65 μ to 72 μ long, the handle of which is long. Genital pores unilateral. Eggs ovoïd, and containing a very long embryo.

4. *Drepanidotænia sinuosa* Zeder.—Length 50 mm. to 160 mm.—to 330 mm. according to Rudolphi. Capillary anteriorly, and 1 mm. to 2·25 mm. broad behind. Head nearly globular; rostellum carrying, like the preceding worm, a single crown of 10 hooks from 40 μ to 60 μ in length, the handle being long. Genital pores unilateral. Scolex marked by a line of black points—one on each segment; it is the pouch of the cirrus (?), which is globular. Dujardin found this to be a rather common species in the Duck.

5. *Drepanidotænia gracilis* Zeder.—Length 27 cm., breadth 1·5 mm. to 2 mm. Head globular. Rostellum slender, armed with a simple crown of 8 hooks 67 μ to 80 μ long, and having a long handle like the two preceding species. Neck very short. Anterior part of the body very slender for most of its length; first segments infundibuliform, the succeeding ones being nearly square. Genital pores unilateral. Th. Scott has found in an ostracode crustacean —*Candona rostrata*—a cysticercoïd 200 μ long and 180 μ broad, which Blanchard has remarked to have a crown of hooks the same in number, shape, and dimensions as those of the *D. gracilis*; and he considers it to be the larval condition of this Cestode. It is the same as Von Linstow has seen in the intestine of a Perch which had, no doubt, swallowed an ostracode that harboured the cysticercoïd. It remains to demonstrate, experimentally, the reciprocal filiation of the larval and the tape forms.

6. *Dicranotænia coronula* Duj.—Length 40 mm. to 190 mm., breadth 2 mm. to 4 mm. Head nearly rhomboidal. Rostellum thick, and armed with a simple crown of 18 to 26 hooks 14 μ to 15 μ long, their guard being larger than the handle. Genital pores unilateral. Found by Dujardin at Rennes, and by Krabbe in Denmark.

7. *T. megalops* Nitzsch.—Length 5 cm., breadth 1 mm. to 2 mm. Head large and nearly quadrangular, with large suckers; no hooks (?). First segments very short; the succeeding ones short and cuneiform in shape, with acute angles. Rare.

8. *Mesocestoides imbutiformis* Polonio.—Length 10 mm. to 12 mm. Scolex very small, unarmed, sucker discoïd. No neck. First segments linear, the middle ones campaniform, and the last ones quadrangular. Genital pores elliptical. Found in Italy by Polonio.

TREMATODES.—Though the species of Trematodes found in the intestine of the domesticated Duck are less numerous than those of the Fowl, yet they are more frequent—a circumstance connected

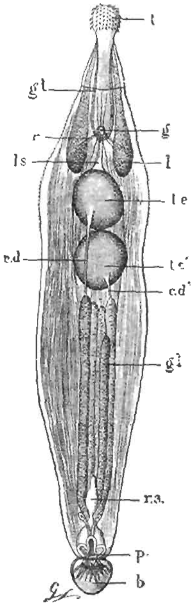

FIG. 254.—Male *Echinorhynchus polymorphus*; magnified 20 diameters. — Railliet.

t, proboscis; *gl*, nerve ganglion; *l*, lemnisca; *r*, retractor or retinacular muscles; *ls*, suspensory ligament; *te*, *te'*, testicles; *cd*, *cd'*, deferent canals; *gl*, prostate glands; *rs*, seminal reservoir; *p*, penis; *b*, caudal pouch.

with the habits of the Palmipedes, which cause them to frequent so much those damp places where the Trematodes find the host necessary to the first phases of their development.

1. *Notocotyle verrucosum* Frölich.—This has been already described among the intestinal parasites of the Fowl (Fig. 251), in which it is rare; it is more frequent in the Duck, but yet not common.

2. *Monostomum caryophyllinum* Rud.—Body 40 mm. long, 1·12 mm. broad, and depressed, the borders being slightly crenellated in front, a little narrow behind, and obtuse at the posterior extremity, widened in front like a head, with a great rhomboidal mouth placed beneath (Rudolphi). Inhabits the intestine of the Stickleback, and has been found by Gurlt, at Berlin, in the intestine of a domesticated Duck, into which it had doubtless been introduced with the Fish upon which the bird fed.

3. *Distomum echinatum* Zeder.—This is the species we have described amongst the intestinal Trematodes of the Dog. It is much more frequent in the domesticated Duck, Dujardin having met with it in 3 of 25 he examined; and at the Vienne Museum it was found in 4 of 11 Ducks.

4. *Distomum oxycephalum* Rud. — Already described in alluding to intestinal helminthiasis of the Fowl. It is more frequent in the Duck.

ACANTHOCEPHALA. — Three species of Echinorhynchus live in the intestine of the Duck, without causing any perceptible disturbance in its health.

1. *Echinorhynchus polymorphus* Bremser.—So named because of the shapes it assumes, according to its age. Its length varies between 4·12 mm. and 25 mm. The body is orange-red in colour, cylindrical, and in early age studded with thorns which are gradually shed as the worm grows; but they persist longer on the anterior than the posterior part, and are altogether absent on the adult. It has a constriction like a neck in front supporting an ovoïd proboscis capable of being retracted into a sheath that contains it; it is armed on its surface with 8—sometimes 9—rows of 8 hooks each. Ova fusiform, 10 μ long and 20 μ broad, covered by a triple envelope.

We owe to Greeff precise information as to the development of this species. When mature, the ova contain an orange-red embryo, 61 μ long and 14 μ broad. The whole of its surface is covered with thorns, which are strongest on the anterior part, at the end of which is a depression or cephalic pore. At each of the two poles of the body is a pair of large hooks. The anterior extremity is indicated by the constriction in the form of an unarmed neck, by which it is followed. Greeff has recognised the larval form of this para-

site in the fresh-water Shrimp—*Gammarus pulex*; in which it has been named *Echinorhynchus miliaris* Zenker. Von Siebold has also seen it very often encysted in the intestinal walls of the Crayfish—*Astacus fluviatilis*. After giving Ducks fresh-water Shrimps containing these larval *Echinorhynchi*, Greeff found the *Echinorhynchus polymorphus* in their intestine.

2. *Ech. filicollis* Rud.—The *female* measures 13 mm. to 30 mm. long, the *male* 7 mm. to 8 mm. The female is yellowish-white, the male white. Rostellum provided with 216 hooks arranged in 18 radiating series of 12 hooks each. The body is similar to that of *Ech. polymorphus*. Ova elliptical, rounded at their poles, and 62 μ to 70 μ long by 19 μ to 23 μ broad.

3. *Ech. sphærocephalus* Bremser.—From 6 mm. to 17 mm. long, and 1 mm. to 3 mm. broad. Proboscis globular, and entirely studded or only partially armed with hooks, or quite smooth, and supported by a neck 1·5 mm. to 4·5 mm., which is nude and filiform.

NEMATODES.—1. *Ascaris crassa* Desl.—Body a dirty reddish-white colour, and attenuated at the extremities. *Male*, 12 mm. long, and 0·5 mm. broad; tail thin, conical, and acute; two long, cylindrical spicules, expanded at their base, and provided with two accessory layers or sheaths. *Female*, 49 mm. long, and 2·2 mm. broad; tail thin, conical, acute, and straight; vulva a little behind the middle. Often found at Caen by Deslongchamps, in the domesticated Duck, and in 3 of 27 by Dujardin at Rennes.

2. *Heterakis papillosa* Bloch.—This parasite of the Fowl has been recognised in the domesticated Duck of Turkestan by Von Linstow.

3. *Heterakis lineata* Schneider.—Body yellow, and 6 cm. to 7 cm. long in the *male*, 9 cm. to 10 cm. in the *female*. Pre-anal sucker little developed, with 11 papillæ on each side. This species, which was observed in a Brazilian Cock by Schneider, has been seen in the Turkestan Duck by Von Linstow.

ARTICLE V.—Parasites of the Intestine of the Goose.

INFUSORIA.—The *Trichomonas Eberthi* lives in the intestine of the domesticated Goose, as in that of the Fowl and Duck.

COCCIDIA.—Zürn has described, as occurring in Geese, a coccidian enteritis very similar to that of Ducks. Biernacki has observed an intestinal coccidiosis which in four days killed 100 in a flock of 320 Geese. The symptoms were languor, inappetence, great thirst, and profuse diarrhœa, the fæcal matters sometimes containing blood. The intestinal contents were fluid, offensive, of a dirty greyish-white, and held in suspension dry greyish nodules of the size of a hemp-seed. The mucosa was studded with similar nodules, and was ulcerated in places. In the intestinal contents and mucous membrane were numerous coccidia which have been connected with *Coccidium avium*. The addition of ferrous sulphate and glycerin to the drinking water gave good results.

CESTODES.—All the Tæniadæ of the domesticated Goose belong to the genus *Drepanidotænia* Raill., and have a single crown of eight to ten hooks with long shafts. Genital pores unilateral.

1. *Drep. sinuosa* Zeder.—Already described among the Tæniæ of the Duck. Dujardin, according to Rudolphi, is said to have found it commonly in the Goose.

2. *Drep. lanceolata* Bloch.—From 30 mm. to 90 mm. long, and 5 mm. to 8 mm. broad; exceptionally, 130 mm. long by 12 mm. broad. Head small

and oval, with a crown of 8 (Krabbe) or 10 (Dujardin) hooks, 31 μ to 38 μ long. Neck null, or very thin, short and retractile, like the head. Strobila lanceolated, the segments being short and gradually increasing in breadth. This is the Tape-worm most frequently met with in the Goose. Frisch—who discovered it in 1727—found it so often that he believed it to have been the cause of a veritable epizoöty.

3. *Drep. fasciata* Rud.—Length 60 mm. to 100 mm., breadth 0·6 mm. to 1 mm. and 2 mm. Head hemispherical or subtetragonal, and often absent in well-developed individuals. Rostellum long, thick and cylindrical; crown single, with 8 or 10 hooks 40 μ to 60 μ long. Neck twice as long as the head. Segments short and wide, and all traversed by a median, longitudinal and obscure band.

4. *Drep. setigera* Frölich.—Length 200 mm., breadth 2 mm. to 3 mm. Head globular; rostellum long and retractile, and armed with 10 hooks from 35 μ to 40 μ long. Neck short and distinct. First segments very short, and the succeeding ones infundibuliform, with very salient posterior angles; genital pores situated near the anterior angle of the segment. Penis rather thick, bristling with spines.

5. *Drep. tenuirostris* Rud.—Length 10 cm. to 25 cm., breadth 1 mm. to 3 mm. Head subglobular, with thin rostrum, armed with 10 long hooks (20 μ to 23 μ). Segments prominent and serrated at their posterior angles.

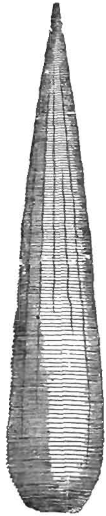

FIG. 255.—*Drep. lanceolata* of the domesticated Goose; natural size and moderately extended.—Railliet.

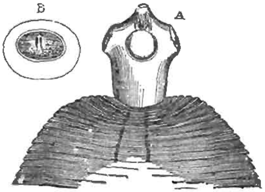

FIG. 256.—*Drep. lanceolata.*
A, cephalic extremity; magnified 100 diameters. B, ovum; magnified 300 diameters.—Railliet.

Found in the domesticated Duck by Railliet; has probably for larva a cysticercoid (*Cercocystis Drep. tenuirostris*) found in fresh-water Shrimps (*Gammarus pulex*), in *Cyclops agilis* and *C. pulchellus*.

TREMATODES.—1. *Notocotyle verrucosum* Frölich.—Found in the large intestine and cæca of the Goose, and less frequently than in the Duck, though not so rarely as in the Fowl.

2. *Distomum echinatum* Zeder.—Less frequent than in the Duck. In the Vienne Museum it was only met with in 2 of 139 Geese.

3. *Distomum oxycephalum* Rud.—Less frequent than in the Duck, though not so rare as in the Fowl.

4. *Cephalogonimus ovatus* Rud.—Already described for the Fowl. It is sometimes found in the intestine and in the sac of Fabricius.

ACANTHOCEPHALA.—The *Echinorhynchus polymorphus* has been met in the intestine of the Goose, but less often than in that of the Duck.

NEMATODES.—1. *Heterakis dispar* Schrank.—Mouth with three very small lobes. Two lateral wings on the neck, becoming narrower as they proceed to the tail. *Male* 12 mm. to 18 mm. long, the tail terminating in a fine long point; pre-anal sucker salient; ten papillæ. *Female* 16 mm. to 23 mm. long vulva situated at the middle of its length (Fig. 256).

This species—which is very closely related to *Heterakis papillosa* of the Gallinacei—has been seen in the intestine of fat Geese by Frölich, Schrank, and Zeder; it does not appear to be common. Railliet has recognised as *H. papillosa*, the Heterakis found by Lucet in the cæcum of the Goose.

2. *Strongylus tenuis* Eberth.—Body dentated on the borders, in consequence of the cuticular projection of the segments. Three small buccal papillæ. *Male* 6·5 mm. long; two equal spicules; pouch ample, bilobate, with numerous ribs, one of which on each side is curved like a hook in front. *Female* 7·3 mm. long, tail acute; vulva situated a short distance from the posterior extremity of the body. Rare.

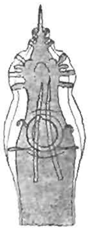

FIG. 257.—*Heterakis dispar*: caudal extremity of the male, seen on the ventral surface; magnified 50 diameters.—Railliet.

FIG. 258.—*Strongylus tenuis*: caudal extremity of the male; magnified 150 diameters.—Railliet.

Lucet has observed an epizoötic tæniasis which, on one farm, had killed 30 of a flock of 36 Geese. These birds had come from different parts, were about two months old, and had probably acquired the germs of their tæniasis in a pool where they drank. The disease was at first obscure, and was manifested by arrest of growth, emaciation, difficult and stumbling progression, a yellow and fœtid diarrhœa, and plaintive cries emitted from time to time. The appetite remained normal until nearly the last—death ensuing in five to seven days after the appearance of the first symptoms. The malady was due to *Drepanidotænia setigera*, the number in each Goose being always high—as many as 93. With these worms were also found 3 or 4 *Drep. lanceolata*.

The treatment consisted in giving cakes in broth or crumb of bread, containing santonica, wormwood, absinthe, crushed garlic, and powdered male fern.

3. *Trichosomum brevicolle* Rud.—Anterior part relatively short. *Male* 10 mm. to 12 mm. long; *female* 20 mm. to 24 mm. long. Of 139 geese dissected at the Vienne Museum, only 18 had this parasite in their intestine.

Parasites of the Intestine of the Swan.

ACANTHOCEPHALA.—*Echinorhynchus polymorphus* Bremser.—This worm—which is more frequent in the Duck—is noted by Bellingham as found in the Swan. It has also been met with in great numbers by Walley, in the small intestine of a Bird of this species.

NEMATODES. — *Filaria cygni* Rud. — A species found by Redi, to the number of more than 200, in the abdominal cavity, and even in the intestine of a very emaciated Swan. These worms were very slender, and measured from ·20 mm. to ·24 mm. long.

CHAPTER IV

PARASITES OF THE LIVER

THE liver is one of the organs in which parasites are most frequently found. The species are not very numerous, and only a few among them play an important pathogenic rôle; but these are very common in the liver of certain of the domesticated animals, and are present in such quantities as to occasion serious epizoötics.

If the liver is one of the seats preferred by parasites, this is probably because of its proximity to the intestine; the germs introduced into the latter—with the food and water—can, after undergoing a primary evolution in the digestive canal, reach that organ in ascending from the duodenum, along the *ductus communis choledochus*. And it is not impossible for some to penetrate the intestinal walls, and so reach the hepatic parenchyma. But the normal route, by which the majority certainly reach the gland, is the vena portæ; in traversing the wall of the intestine, they pass into some capillary that brings them to the great mesenteric vein, or into one of the radicles of the right gastro-omental vein, and thence into the portal vein—that open door to all ills, as Stahl said in a paradoxical exaggeration. The comparative slowness of the circulation in this vessel, ought also to favour the arrest of the parasites in the hepatic organ.

Many of these parasites have no influence on the health of their host; but when they are in great numbers they retard the flow of bile, and so bring about grave alterations which react upon the circulation and general nutrition, and anæmia is the consequence.

The gravity of certain parasitic affections of the liver, is owing to the fact that—with only rare exceptions—medicaments cannot reach the parasites in the depths of the organ in which they are lodged.

Among those worms which may be met with in the liver of the domesticated animals, there are some that need not be referred to at present. These are:

1. *Linguatula denticulatum*—a larval form of *Linguatula tænioides* of the Dog's nasal cavities, is found in its first stage in the mesenteric glands, and the liver and lungs of the Ox, Goat, Camel, Horse, Cat, Rabbit, Hare, Guinea-pig, and even of Man. It will be described when dealing with *Linguatula tænioides*.

2. Coccidia, and particularly *Coccidium cuniculi*, which will be studied with regard to its effects.

3. Echinococci, which are found in very diverse organs of the several domesticated species—particularly in the liver—and which will be studied after the preceding.

4. Distomea, the two principal species of which—*Distomum hepaticum* and *D. lanceolatum*—by their accumulation in the biliary ducts, give rise to a particular malady—*Distomiasis*—which will be described at the end of this chapter.

The others are of less importance, and we will, therefore, only briefly notice them. They belong to the same classes or orders which have so many representatives in the intestine.

FUNGI.—*Saccharomyces guttulatus* Ch. Rob.—This is found in the intestine of the Rabbit, Ox, Sheep, and Pig; and Remak has met with it in the biliary ducts of the Rabbit.

INFUSORIA.—*Monocercomonas hepatica* Rivolta.—A round, oval, or angular body, very mobile or non-mobile, 6 μ to 8·5 μ in diameter, provided with one or two flagella, and containing a granular, contractile protoplasm, with vacuoles, and two nuclei; it shows also a transverse internal line. Found by Rivolta in a young Pigeon, the liver of which—larger and firmer than in the normal state—was studded with yellowish nodules varying in size, from a mere point to a pea or small nut—caseous hepatitis. They were found in every part of the organ; but were confluent at its borders. The adjoining air-sacs were hyperæmic, and covered with a yellow gelatinous exudate.

CESTODES.—Various cystic forms of the Tæniæ of the Dog may be found in the liver of the Herbivora. A great number, in the embryo stage, must pass through that organ in order to reach the location that suits their larval condition; but there are among them those which remain in the liver, having attained their definitive form—such are the Echinococci, which will be dealt with separately; while others stay there by accident or only temporarily, and produce marked or scarcely appreciable alterations. Those which may be encountered in this way—besides the Echinococci—are the following:

1. *Cysticercus tenuicollis* Rud.—This is the cystic form of the *Tænia marginata* of the Dog. It is met with in the peritoneum—more rarely in the pleuræ and pericardium—of various animals, more especially Ruminants, and sometimes the Pig. The experiments of Baillet have shown that this Cysticercus reaches the peritoneal cavity through the liver. In a Lamb and Kid which died ten days after ingesting segments of *T. marginata* that authority found the liver traversed by numerous very sinuous channels, each of which was partially blocked by a small blood-clot, and was occupied by one, two, or three transparent, globular vesicles. Before death, the animals exhibited all the symptoms of internal hæmorrhage; the abdominal viscera were bathed in blood, which the slightest pressure caused to transude from every part of the liver. Another Kid succumbed on the twenty-fifth day; it showed signs of a violent peritonitis and complete 'disorganization of the

liver.' But these lesions have scarcely been observed except in experimental cases; for in natural infestation the Cysticerci are always few, and pass through the liver without producing any apparent disturbance to health—forming, in the peritoneum, those large vesicles that the French butchers call *boules d'eau*.

Nevertheless, Leuckart has pointed out the possibility of grave—even fatal—accidents to the Pig, when Cysticerci are in large number. The lungs, and more especially the liver, show numerous inflammatory centres, each occupied by a Cysticercus; they are also excavated by galleries, at the end of which is lodged one of these parasites; while there may be evidences of hæmorrhage and fatal peritonitis. Boudeaud has reported such a result occurring in a young Pig, which died after showing symptoms that might have led to the supposition that the animal was suffering from pneumo-enteritis. Semmer found the liver of a Pig invaded by a great number of cysts, varying in size from that of a small nut to a hen's egg, each of them being occupied by *Cysticercus tenuicollis*; the internal appearance of the organ resembled that observed in Echinococcosis.

Putz reports the death of a Cow from hepatitis and peritonitis, due to the presence of an enormous quantity of *Cysticercus tenuicollis*.

FIG. 259.—Portion of the surface of the liver of an artificially-infested Rabbit, showing the vascular tracks of the *Cysticercus pisiformis*, as well as numbers of that parasite at the second day of their development; slightly magnified.—G. P. Piana.

2. *Cysticercus pisiformis* Zeder.—This is the cystic form of another Tape-worm of the Dog—the *Tænia serrata*; it lives in the Rabbit, and only attains its final development in the peritoneal cavity. But in order to arrive there it must pass through the liver, and in doing so it produces very interesting alterations in that organ, which have been particularly studied by Küchenmeister, Baillet, Leuckart, Moniez, and Laulanié.

When a Rabbit ingests the ova of *T. serrata*, there are seen in the liver—after the second day—very small white nodules and fine rudimentary streaks. The tubercles or nodules rapidly increase in volume, and on the fifth day they are as large as a hemp-seed, and are somewhat hard; they cannot be enucleated without tearing away fragments of hepatic tissue. These nodules—which are little, if at all, transparent—are formed of a very thick envelope containing a refrangent ovoïd body; this envelope passes insensibly into the tissue of the liver, and is produced merely by the transformation of the hepatic cells; while the central portion recalls nothing of the embryo, but is only more advanced in degeneration. Often this nodule contains very characteristic pus, and from this it might be concluded that these productions are evidence of a local inflammation of the liver, which has been set up around

a dead embryo, or one incapable of resisting an eliminatory process.

Independently of these nodules, and distributed—like them—on the surface, as well as in the substance of the liver, are observed *numerous sinuous streaks running in every direction*, of a transparent grey tint in the centre, and bordered by a yellow line. Laulanié has recognised these as always branches of vessels from the sub-lobular vein; and it is here that is found the already more or less advanced embryo. It occupies the centre of a mass of coagulated blood, that adheres at some points to the wall of the vessel, which is the seat of a very abundant proliferation of embryonic cells. From this there arises within the sphere of action of the obliterated interlobular vessel, a venous cir-

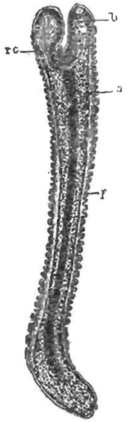

FIG. 260.—Development of the *Cysticercus pisiformis*.—After Moniez.

A month-old larva, taken from a superficial gallery in the liver of the Rabbit. It is already marked by numerous folds or papillæ, *p*, and does not yet show any signs of dropsy; *a*, central portion, finely granular, which marks the point where the tissues rupture. The point marked *b*, to the rudiment of the head, *rc*, represents the future *receptaculum capitis*. Magnified 15 diameters.

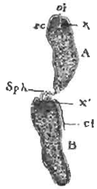

FIG. 261.—*Cysticercus pisiformis* in process of division at the twenty-second day.

A cord *sph* unites the two parts of a larva that was originally whole, and marks a sphacelated portion of the Cysticercus. At the superior end of the segment A is seen the rudiment of the head of the receptaculum (*rc*, *x*); there is something analogous to it in part *B*; *ct*, layer of cuticle which is detached; *oi*, orifice of invagination. Part A forms the future animal, part B being destroyed.—Moniez.

rhosis—mono- or multi-lobular—which assumes two exceptional characters. The connective-tissue productions which fill the spaces and liver-fissures are remarkable for: 1. the multiplicity of their capillary vessels and the ectasia of which they are the seat; 2. the presence of a variable number of giant-cells, which sometimes attain an enormous volume, and in their distribution do not appear to

submit to any recognised law. Piana had already recognised the presence of giant-cells in the vessels containing young *Cysticerci pisiformes*; and he also observed that these giant-cells are often invaded by Bacteria, which he supposed had been brought from the intestine by the embryos.

The latter measured scarcely more than 1 mm. long and much less in breadth, and were composed of a very delicate reticulum enveloped in a thin cuticle. At the end of twelve days they were already 3 mm. long, and manifested obscure contractile movements. In developing, they become elongated, and their galleries are widened. At the twenty-second day they are about 1 cm. long and less than 1 mm. broad; and at this period they offer a curious phenomenon, discovered by Moniez. The Cysticercus is strangulated in the middle (Fig. 261), and divides into two portions which, attached to each other by a more or less constricted and twisted funicle that in time becomes atrophied and absorbed, leaving the moieties completely separated. One of these is probably destroyed, and the other soon forms a rudimentary Tape-worm head, by budding; consequently, it alone constitutes the definitive Cysticercus.

It is in about a month after infestation—often less—that the Cysticerci quit the liver and spread over the peritoneal cavity; they are sometimes found protruding from the surface of the liver. Soon they are free, slightly dropsical, and of various degrees of development, being then most frequently lodged between the two serous surfaces, when they form their cyst and establish themselves. The galleries they have quitted disappear after a time, and leave more or less marked cicatrices on the surface of the gland.

Hepatic Cysticercosis may manifest itself beyond experimental conditions, and produce a morbid state of a cachectic nature that sometimes terminates in death. We have observed such instances.

TREMATODES.—Creplin has given the name of *Amphistomum explanatum* to a species found by Gurlt at Berlin, in the biliary duct and gall-bladder of a Zebu. It is a lanceolated oval, 9 mm. long and 4 mm. broad; the posterior sucker is sub-elliptical, and spread out at the sides.

The other Trematodes of the liver are Distomes—*Distomum hepaticum*, *D. lanceolatum*, *D. truncatum*, and *D. sinense*, the effects of which will be indicated hereafter (Art. *Distomiasis of the liver*).

NEMATODES. —*Ascaris megalocephala* Cloq., and *Ascaris suis* Dujar.—Ascarides may enter the biliary duct and give rise to serious colic, as Röll has remarked with regard to the Ascarid of the Horse. Camberoque has observed epileptiform seizures in a Pig, at the autopsy of which he found no other lesion than congestion of the duodenum and the adjoining peritoneum, and the presence of a bundle of Ascarides at the opening of the ductus choledochus; one of these bundles was entirely engaged in the duct, and another fixed there by its anterior part.

Œsophagostomum dentatum Rud.—Reported by Von Linstow as found, not only in the intestine, but also in the liver of the Pig.

Sclerostomum equinum Rud.—Mégnin has found the middle lobe of the liver of a horse transformed into a real fibro-plastic tumour, dense at some points, soft in others, and studded with small blood-cysts, each of which contained a *Sclerostomum equinum*—male or female—from 2 cm. to 4 cm.

long, and doubled up on itself. The females contained non-fecundated ova only. In the left lobe of the liver of a Horse, at the border of its posterior surface, Colucci discovered an inflammatory tumour to be occupied by a Sclerostome which he considered had come from the intestine and penetrated the gland by a foramen 1 mm. wide, visible on the anterior surface of this left lobe.

Ollulanus tricuspis Leuck.—We have seen that the embryos of this species —a parasite of the stomach of the Cat—may wander into the liver.

Filaria hepatica Cobb.—These are worms found by Mather, encysted in the intestinal tunic and biliary canals of a Dog.

Embryos of Filariæ.—Colin and Reynal were the first to make mention of the presence, in the liver of the Horse, of white or yellow, calcified, and irregularly spherical nodules, formed of numerous concentric layers. Their volume varied from the size of a millet-seed to that of a pea, though there were some which were scarcely visible. Oreste and Ercolani were of opinion that these nodules had the ovum of a Distome for a nucleus; but according to Mazzanti, they are produced by the embryos of Nematodes carried by the blood, as a capillary was in the centre of each nodule. He sometimes found 4 to 6 in the same tubercle. They insinuated themselves into the parenchyma, through the walls of the bloodvessels, and gave rise to irritation—either in the lobules or the interlobular connective-tissue—that ended in the formation of these pseudo-tubercles. They measured 40 μ to 180 μ long and 3 μ to 6 μ in diameter, and differed from those of *Filaria papillosa*, but belonged, no doubt, to an undetermined species of Filaria.

Eustrongylus gigas Rud.—This parasite of the kidneys has been found in the liver of a Dog by Lissizin (see *Parasites of the Urinary Organs*).

Before passing to the description of psorospermosis of the liver, echinococcosis, and distomiasis, we here give a list of the hepatic parasites of the domesticated animals.

Equidæ.—*Ascaris megalocephala, Sclerostomum equinum, Filaria* sp. ?, *Distomum hepaticum, Linguatula denticulatum.*

Ox.—*Amphistomum explanatum, Distomum hepaticum, D. lanceolatum, Cysticercus tenuicollis, Linguatula denticulatum.*

Sheep and Goat.—*Distomum hepaticum, D. lanceolatum, Cysticercus tenuicollis, Linguatula denticulatum.*

Pig.—*Œsophagostomum dentatum, Distomum hepaticum, D. lanceolatum, Cysticercus tenuicollis, Cyst. cellulosæ* (see *Measles of the Pig*).

Dog.—*Filaria hepatica, Eustrongylus gigas, Distomum truncatum, Cysticercus cellulosæ* (see *Measles of the Dog*).

Cat.—*Ollulanus tricuspis, Distomum truncatum, D. lanceolatum, D. sinense, Cœnurus* sp. ?

Rabbit.—*Saccharomyces guttulatus, Eimeria falciformis, Coccidium oviforme, Cysticercus pisiformis.*

Pigeon.—*Monocercomonas hepatica.*

ARTICLE I.—Coccidiosis of the Liver.

Coccidiosis, or Psorospermosis, of the liver is a frequent parasitic affection in the domesticated Rabbit, and is caused by a Sporozoon —the **Coccidium cuniculi** (Rivolta), *Coccidium oviforme* (Leuck).

History.—This parasite appears to have been first seen in the Rabbit by Carswell, then by Hake in 1839, Nasse in 1843, Handfield Jones in 1846, etc.; but its nature was for a long time unknown. Hake mistook the Coccidia for pus corpuscles, and Lang considered them to be neoformations; while a number of observers believed them to be the ova of Nematodes, Distomea, Tæniæ, or Linguatulæ; or they were mistaken for the Utricules

of Miescher—Sarcosporidia. Davaine—in consequence of their great resemblance to the ova of Helminthes—named them *Corps oviformes*, by which designation they were for a long time known. However, in 1845, Remak, recognising them as parasites, proposed to class them with the Psorospermiæ, a group created by F. Müller, in 1841, for certain parasites of Fishes (the *Myxosporidia*). From their aspect they were named *Psorospermiæ oviformes*. In 1879, Leuckart instituted the class of Sporozoa in which he placed the *Psorospermiæ oviformes*, and named them Coccidia.

The study of the Coccidia, based at first on the work of A. Schneider and of Balbiani, since 1892 has made considerable progress, and the researches of R. Pfeiffer, Simond, Leger, Labbe, Siedlecki, etc, have demonstrated that the Coccidia are reproduced in two ways: sexually (sporogenesis) and asexually (schizogenesis).

Coccidium oviforme.—In the encysted state, as it may be found in the biliary canals of infested Rabbits, the parasite is an ovoid body—30 μ to

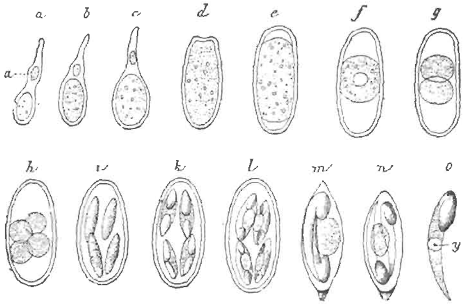

FIG. 262.—Evolution of the *Coccidium oviforme* of the Rabbit's liver.—After Balbiani.

a, *b*, *c*, young Coccidia contained in the epithelium of the hepatic canaliculi; *a*, nucleus of the epithelial cell; *d*, *e*, *f*, encysted adult Coccidia; *g*, *h*, *i*, *k*, *l*, development of the sporoblasts; *m*, mature sporoblast, much magnified, showing the two falciform corpuscles or *sporozoites* in their natural position, with the remains of the granular mass (*nucleus de reliquat*); *n*, compressed sporoblast, with the two corpuscles separated from each other; *o*, a spore; *y*, its nucleus.

50 μ long by 14 μ to 28 μ broad—enclosed in a double contoured shell (cyst), with a depression (micropyle) at one of its poles. At first the cyst is filled with protoplasm; very soon the latter separates from the wall and contracts into a nucleated spherical mass (Fig. 262, *f*). It is the last phase of parasitic development observed in the liver; the Coccidia pass with the bile from the liver into the intestine, and are carried out with the excreta. Their ulterior evolution takes place in water or in moist earth. If some of the ripe cysts from an infested liver are placed under a thin layer of water, on damp sand, or on a piece of charcoal in a moist chamber, their development may be followed. The rapidity of their evolution depends upon the conditions of temperature and oxygenation in which they are placed. The process may be completed in from ten to fifteen days (Balbiani), or in four or five days according to R. Pfeiffer. Segmentation divides the protoplasmic sphere into two, then into

four smaller spheres or *sporoblasts*; each of these elongates, surrounds itself with a double membrane, and becomes a *sporocyst*. The division of the contents of each sporocyst results in the formation of two nucleated comma-shaped protoplasmic bodies (*sporozoites*) placed in inverse direction—the rounded extremity of one being in contact with the pointed extremity of the other—and between them may be seen the remains of the granular mass. In this state the cysts may exist without alteration for a very long time in external media. Introduced into the intestine with the food or water, the ripe cysts are dissolved by the pancreatic juice; the sporocysts, set free, open and liberate the sporozoites which more or less rapidly gain the biliary canals and invade their epithelial cells.

The multiplication of *Coccidium oviforme*, within the epithelial cells, is accomplished by fecundation and by schizogenesis after the manner already indicated (p. 272). Fecundation has not been observed in *Coccidium cuniculi*, but probably it is identical with that which has been seen in allied species. Influenced by chemotactic attraction, several microgametes come in contact with the macrogamete; one of them penetrates by the micropyle, which is then closed. The male nucleus blends with the female nucleus, and together they constitute the *oöcyst*: it is the encysted coccidium or *sporont*, which by sporogenesis, will produce sporoblasts, then sporozoites.

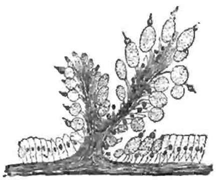

FIG. 263.—*Coccidium oviforme* in the epithelial cells of the hepatic ducts, displacing the nuclei of the cells.—Balbiani.

Pathological Anatomy.—At the autopsy of a rabbit affected with Coccidiosis, the liver may present its normal volume and weight if infestation is not very marked; but generally it is much larger in size and heavier—sometimes treble its normal condition, and all the lesions of cachexia and abdominal dropsy are observed. The hepatic parenchyma is studded or crammed with whitish-yellow cysts, from the size of a millet-seed to that of a pea, or even a nut; and globular, elongated, or lobulated, giving the surface of the liver a mammillated appearance. Their number is at times so great that the intervening parenchyma is completely atrophied. These cysts contain a thick, yellow, creamy, grumous or caseous matter, chiefly composed of the encysted Coccidia, epithelial cells undergoing fatty degeneration, free nuclei, and fat-drops. The membrane limiting these nodules is only the altered wall of a hepatic canal, which, under the influence of irritation, has formed a thick capsule of connective tissue, constituted by concentric fibres and numerous nuclei.

These altered and transformed hepatic tubes have generally maintained their communication with the neighbouring canaliculi; though it may happen that a connective-tissue formation has isolated and encysted them, in a manner analogous to the encystment that takes place around foreign bodies or old tubercles. The gall-bladder contains products very similar to those in the hepatic nodules, which indicates a communication, more or less direct, between the nodules and the biliary canals.

The hepatic lobules have undergone various changes. Sometimes they are replaced by connective tissue, as in biliary cirrhosis; at

other times they are atrophied by the peripheral compression of the parasitic cysts, or by hypertrophy of the interlobular connective tissue.

The Coccidia show themselves in two principal forms—free or encysted. The free Coccidia (schizonts, merozoites, or young macrogametes) are most frequently spherical or slightly elongated, and measure 11 μ to 14 μ broad, and 17 μ to 22 μ long. Some are almost homogeneous and very refrangent, with a darker central point; the others are altogether granular, without a central point, and resemble cells undergoing fatty degeneration; their volume varies from 6 μ or 8 μ to 30 μ. They are often included in epithelial cells, and solitary or grouped in small masses in the same cell. The encysted Coccidia (*oöcyst*) may also exist in the interior of a cell; and, like the preceding, they are sometimes lodged in large giant-cells.

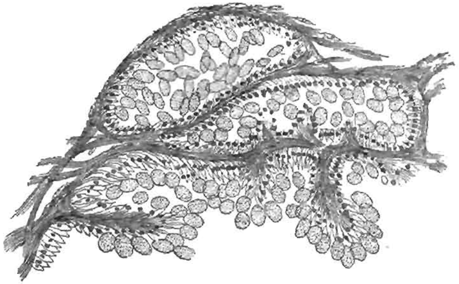

FIG. 264.—Section from the liver of a Rabbit invaded by the *Coccidium oviforme*. The hepatic ducts are dilated by the parasitic productions. —Balbiani.

It is not rare to find white particles floating in the bile, similar to the contents of the tumours, and almost exclusively formed of Coccidia. Rivolta once found numerous encysted Coccidia in the epithelium of a dilated gall-bladder.

Symptoms.—Interference with the biliary secretion, alteration of its product, destruction of hepatic tissue, and vascular compression explain the symptoms by which Coccidiosis of the liver is manifested when the disease involves a large part of the organ.

The Rabbits lose flesh, the appetite disappears, and the fur loses its lustre and becomes matted; they are also less lively and alert. Notwithstanding good food, they continue to waste, their mucous membranes become pale or assume an icteric tint, the hair is erect, the weight rapidly diminishes, and marasmus is accentuated by tympanites; there is ascites, an exhausting diarrhœa, uncertain or

staggering movements, etc.; in fine, all the symptoms of pernicious anæmia. Death takes place in convulsions in two or three months. Often, however, a very large number of Coccidia will be found in the liver, and yet the animals during life do not show any evidence of their presence. Claude Bernard found that puncture of the floor of the fourth ventricle in Rabbits affected with advanced Coccidiosis, does not produce diabetes.

Diagnosis can only be established by examination of the fæces, which ought to contain encysted Coccidia. Unfortunately, the hepatic form cannot positively be distinguished from the intestinal form; but the first is much more frequent than the second, which is always accompanied by diarrhœa, and its flux contains many more parasites than that arising from infestation of the liver.

Frequency.—Coccidiosis of the liver is common in Italy, in France, and in England; very rare in America. It is prevalent in the environs of Paris, where rabbits are often crowded in small, badly-kept hutches. Delepine estimates at 92 per cent. the proportion of rabbits affected with Coccidiosis in England. Breeders attribute the development of the disease to an exclusive diet of green food—an opinion supported by the conditions of sporogenesis. But the nature of the food is not the sole cause; dampness of the litter also assists in the propagation of the parasite. Hepatic Coccidiosis and Coccidiosis of the intestine may co-exist. Both are met with concurrently in the wild rabbit, and sometimes in the epizootic form. Ch. Robin appears to have seen *Coccidium oviforme* in the liver of the Guinea-pig. The liver of Man may be invaded by the same parasite (Gübler, Dressler, Leuckart, Silcock, Podwyssozki). Lastly, Johne connects with *Coccidium cuniculi* numerous Coccidia (?) which he found in the liquid contents of irregular-shaped cysts situated at the upper border of the liver of a Pig; but they were three or four times larger than those of the Rabbit, as they measured 120 μ long by 70 μ broad.

Treatment.—Hepatic Coccidiosis may occasion serious loss in rabbit-hutches, and gravely compromise the rearing of Rabbits.

When it is present, it is easy to arrest its ravages by separating the healthy from the diseased animals, and by carefully carrying out disinfection by means of boiling water, in the places where the sick creatures have deposited their excrements, along with the encysted Coccidia. It is more advantageous to sacrifice the diseased or suspected Rabbits, than to undertake their medical treatment. Their viscera should not be thrown on dung-heaps, nor in yards, as is usually done, but burned, or purified by prolonged boiling.

The indications are to have the hutches in dry, and sufficiently well-aired and lighted situations. The Rabbits should be given fortifying healthy food, with hay and corn from time to time, and pure water should always be accessible to them.

ARTICLE II.—Echinococcosis of the Liver.

Echinococci.—The Echinococci (*Echinococcus veterinorum* Rud., *Ech. polymorphus* Diesing) represent the cystic phase of the *Tænia echinococcus* of Von Siebold, which lives principally in the intestine of the Dog. The carnivorous bearer of that Tape-worm expels, with its fæces, the mature proglottides gorged with ova; and the latter, protected by the resistance of their shell from external causes of destruction, are many of them carried into drinking water, or into the alimentary matters of Man and animals, and with them gain access to the digestive canal. The experiments of Von Siebold, Küchenmeister, Van Beneden, Leuckart, etc., have placed beyond doubt the relationship between the Echinococci and the *Tænia echinococcus*.

The Echinococci—also called *Hydatids*—are met with in very varied hosts. They have been found in Man, various species of Monkeys, the Dog and Cat, Ichneumon, Rabbit, Squirrel, Pig, Wild Boar, Ox, Argali, Sheep, Goat, Deer, Giraffe, Camel, Dromedary, Elan, Antelope, Horse, Zebra, Elephant, American Tapir, and Giant Kangaroo. They have also been observed in the Turkey. But they are most frequent in Ruminants and the Pig.

They are met with in the most varied organs, but the liver is the favourite seat; then the lungs, and after them the kidneys, spleen, intestinal walls, serous membranes, heart, muscles, and even the bones. The same animal may be invaded in several of these organs, and instances are on record in which there was general infestation that induced pronounced cachexia. Such was the case of a sow two years old, reported by Dupuy, which had been affected with paraplegia, and was found on examination after death to have hydatids in several muscles of the loins, back and thighs, and in the liver, lungs and kidneys. Mégnin and Lemke have made known similar cases.

The development of the hydatid is very slow. The embryos of the *Tænia echinococcus* probably enter the liver by the portal system. Leuckart, having succeeded in infesting sucking Pigs with ripe segments of this Tape-worm, has noticed beneath the serous covering of the liver, at the end of four weeks, small white nodules scarcely a millimetre in diameter. Each of these consisted of a cyst of connective tissue, formed at the expense of the hepatic tissue, and containing a globular body of a similar structure, which was a young Echinococcus. Two months after infestation, the Echinococci were nearly double that size, and were already dropsical; and towards the end of the fifth month the cysts were the size of a nut—raising the serous membrane more or less, and each contained a hydatid. This was constituted by a spheroid tremulous vesicle with thick walls, whitish in colour, and translucent (the *mother-vesicle*). The wall comprises two quite distinct membranes—an external (*hydatic membrane*), which is a cuticle about ·2 mm. thick, formed of a large number of

concentric layers; and an internal one (*germinal membrane*), which is thin and scarcely ·12 mm. thick. The fluid that distends the hydatid is colourless or slightly yellow, of a neutral or slightly acid reaction. It may contain very diverse substances, the majority of which are foreign to it, and enter it—by endosmosis—from the blood or adjacent organs.

Besides these accidental substances, the hydatids contain variable proportions of a leucomain—discovered by Mourson and Schlagdenhauffen—which is nutritive waste. Its abundance is in proportion to the activity of nutrition, which is very great when the heads of the Tænia are growing, and small at the resting period of the Echinococcus. To the presence of this alkaloid are attributed the urticaria and peritonitis observed in Man, in cases in which the hydatid opens into the large serous cavities.

Exceptionally, the Echinococcus does not get beyond this stage,

Fig. 265. — A proligerous vesicle; highly magnified.—Railliet.

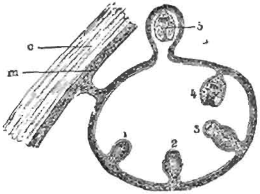

Fig. 266.—Diagram of a proligerous vesicle, to show the manner in which the heads of the Tænia are formed in its interior.—Railliet.

and it is then—since the days of Laennec—named an *Acephalocyst*. But it usually happens that, when the mother-vesicle has sufficiently enlarged, there appear on the internal surface of the germinal membrane, small papillæ arranged in more or less closely-set groups. Each of these has a cavity that gradually enlarges, and the inner surface of which soon becomes differentiated into a thin cuticle. The vesicles thus formed are attached to the germinal membrane by a short pedicle, and are designated *proligerous vesicles*. Their internal face will form the heads of Tæniæ, or scolices; there are usually 5 to 10, or 20, or even 34, in the interior of the same proligerous vesicle, and they are not always of the same age or size. When completely developed, they are small round bodies, measuring on the average ·19 mm. by ·16 mm.; the pole opposite to the pedicle shows a depression formed by the invagination of the head itself, and on the sides are the suckers, at the bottom of a double crown of hooks. The

latter are similar to those of the adult Tænia, though slightly longer, and at the periphery of the head are distributed a considerable number of calcareous particles or corpuscles. Evaginated, it appears as in Figure 267, B. The vesicles burst, and the heads separate from them and float at liberty in the fluid for a long time after the hydatid is dead, or when it is placed in water, which enters it by osmosis.

The proligerous vesicles are not the only mode of multiplication of the Echinococcus; for there may form what are called *secondary vesicles* or *daughter-bladders*, which have all the characters of the *mother-vesicle*. Originating in the substance of the cuticle or hydatic membrane, they gradually distend, then rupture it, and fall external to or inside the mother-vesicle, according to the conditions in which development is effected. In the first case, there are *secondary*

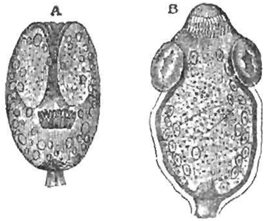

FIG. 267.—*Echinococcus polymorphus.*

A, young Tænia detached from the proligerous vesicle, to which it was fixed by its inferior pedicle; the head is retracted inside the neck. B, the same, with the head evaginated.—After Perroncito.

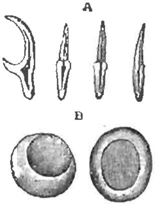

FIG. 268.—*Echinococcus polymorphus.*

A, side and front view of hooks; B, isolated suckers.

external or *exogenous vesicles*, and the Echinococcus has been called *Echinococcus scolecipariens* (Küchenmeister) and *E. simplex* or *E. granulosus* (Leuckart). In the second case, there are *secondary internal* or *endogenous vesicles*, and the Echinococcus has received the names *E. altricipariens* (Küchenmeister) and *E. hydatidosus* (Leuckart).

The mode of formation of these two sorts of Echinococci remains the same, and there is nothing fundamental in the distinction; it may be remarked, however, that the two kinds of secondary vesicles are not generally found in the same Echinococcus, nor yet in the same host.

The secondary exogenous vesicles are more especially common in Ruminants and the Pig, and they are not rare in Man. They usually remain small, and may pass unperceived; they most frequently belong to medium-sized Echinococci.

The secondary endogenous vesicles are most frequent in Man, the Pig, and the Horse—though they have been seen by Railliet also in the Ox; they are generally much larger than the external ones.

The secondary vesicles are also capable of throwing out—by intracuticular budding—other vesicles of a tertiary order, external or internal like them, and called *grand-daughter vesicles*.

The *secondary vesicles*, *daughter*, and *grand-daughter*—external or internal—are capable of developing proligerous vesicles, and, consequently, the heads of Tæniæ, at least as well as the mother-vesicle; like it, also, they may remain sterile and form acephalocysts.

There is also a special form of Echinococcus that receives the name

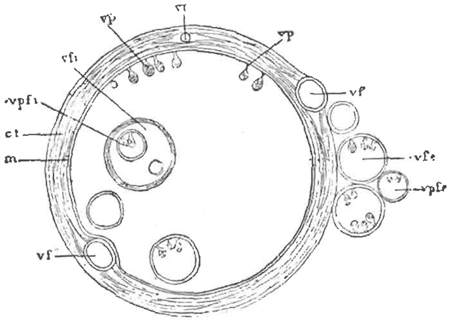

FIG. 269.—*Echinococcus polymorphus*: diagram of the formation of proligerous and secondary vesicles.—Railliet.

ct, cuticle or hydatic membrane; *m*, germinal vesicle; *vf*, secondary or daughter-vesicle commencing its formation; *vf'*, daughter-vesicles passing internally; *vf''*, daughter-vesicle passing externally; *vfe*, external or exogenous daughter-vesicles; *vfi*, internal grand-daughter or endogenous vesicle; *vpfi*, internal grand-daughter vesicle; *vpfe*, external grand-daughter vesicle, which appears to be produced in the multilocular Echinococcus.

of *Echinococcus multilocularis* or *E. alveolaris*, which is distinguished from the preceding by the size of the vesicles—these remaining very small, from the size of a millet-seed to that of a pea at most. These vesicles remain agglomerated in masses, which may grow as big as the head of an infant, and are attached to each other by a common connective-tissue stroma, resulting from the fusion of their adventitious capsules. The masses they form have the appearance of well-defined tumours easy to enucleate, and a section of them shows a number of alveoli, each filled with what looks like colloid matter, but which is nothing more than a vesicle with its wall collapsed and doubled-up on itself. The multilocular Echinococci are less fre-

quently fertile than the ordinary hydatids, and the number of the heads more particularly always remains limited, their discovery sometimes requiring long and diligent search. Little is known as yet with regard to the development of these Echinococci; perhaps they result, as Meyer has said, from exogenous budding of the daughter and grand-daughter vesicles, arising from a small number of the mother-vesicles. They have been more especially observed in Man; but we possess at present 36 recorded instances in which they have been found in animals, 23 of these being due to Ostertag. Only four of them were furnished by the Pig, all the others by the Ox, and nearly all the Echinococci were found in the liver.

The multilocular Echinococcus is distinguished not only by its appearance from the other Echinococci, but it has a particular geographical distribution—at least in Man. Thus it is never seen in Iceland nor Australia, where the hydatic cysts are endemic; and of 182 cases of hydatids observed in Mecklenburg, only one had this form. It is in Wurtemburg, Bavaria, and Switzerland—where the hydatic cysts are relatively rare—that the alveolar Echinococcus has been most frequently encountered. The hydatids of this form observed in Oxen and Pigs were chiefly in the abbatoirs of Munich (Bollinger, Brinsteiner) and of Berlin (Ostertag).

Man alone furnishes important information as to the longevity of the hydatids, and it appears that this may be very great. Courty has observed a case of hydatid in the iliac region, that dated for thirty-five years. Raynal operated on a woman, in whom the swelling had gradually spread during forty-three years over a considerable portion of the face, and attained the size of a child's head. Raymond has seen an Echinococcus persist for seven years in a Horse.

In growing older, the hydatid undergoes modifications. These are sometimes limited to increase in volume and thickening of the cuticle, which may attain 1 mm. By remaining simple, the hydatid is capable of acquiring a diameter of 15 cm.; though this is exceptional, and most frequently it remains no larger than the fist. In general, the increase in size is due to the formation of secondary vesicles, which—if they are internal—cause the mother-vesicle to undergo a dilatation that is rarely regular, and is usually subordinate to the resistance that the organs of the host offer to its extension.

Pathological Anatomy.—Echinococcosis of the liver is more particularly prevalent in Ruminants and the Pig; a few instances have been observed in the Horse and Ass.

It is often difficult to ascertain the number of Echinococci by which the liver is invaded, in consequence of the impossibility of distinguishing the secondary external vesicles from the mother-vesicles.

The hydatids sometimes cause considerable alterations in the liver of their host. There is formed, at first, a cyst for each mother-vesicle, and the external vesicles may remain in this cyst—which is amplified in proportion to their growth; or it may throw out ampul-

lary ramifications, each having one or several secondary vesicles. These ramifications remain in communication with the primary cyst, or separate from it by the constriction of the intermediate canal, causing obstruction, and sometimes its atrophy. The walls of the cyst have a variable thickness, which may be from 5 mm. to 10 mm.; they are coriaceous, resisting, have not many vessels, are smooth on their inner surface, and in general free from adhesions with the surface of the hydatids. The latter can be extracted by careful incisions made with the scalpel guided by a director.

A liver invaded by the Echinococci is considerably modified in its aspect. Its volume and weight are augmented—sometimes tenfold. The liver of the Ox, which, in the normal state, weighs about 5 kilo-

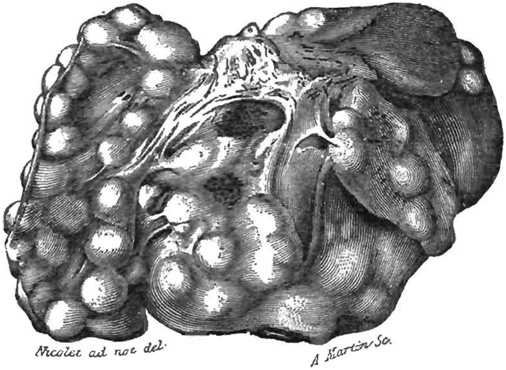

FIG. 270.—Liver of the Pig invaded by an enormous quantity of Echinococci. This liver measured ·56 m. broad and ·41 m. high, and weighed 12·500 kilogrammes (about 27 pounds).—Railliet.

grammes, may when affected with hydatids amount to 50 kilogrammes. East has found it weigh 130 pounds, Roberts and Gregory 145 to 146 pounds, and Ringk 158 pounds. It is the same in the Pig; in health the average weight of this organ is about 2 kilogrammes, but it may acquire an enormous volume—Cartwright has found it to be 50 pounds, and Girard 110 pounds.

The increase in volume entails modifications in the neighbouring organs, which are displaced, compressed, deranged, and hindered in their functions. The curvature of the diaphragm is increased, and the lungs are diminished in size; while the intestine sometimes shows constrictions, and the peritoneum contracts adhesions.

The liver is lumpy on its surface, and instead of a uniform tint, it

shows round white patches corresponding to the hydatids. The visceral peritoneum and Glisson's capsule are notably thickened, and may form adhesions with the diaphragm, intestine, etc. The hepatic tissue is compressed, discoloured, and atrophied, and has become fibrous at points in the vicinity of the hydatids, and particularly at those which are intermediate to two or more voluminous vesicles, where it only appears as an eyot or band. A deep section of the organ lays open round, irregular, and unequal cavities, lined by the cystic membrane, from which the hydatic fluid spurts out, with the intact vesicles.

As they become older, the hydatids are modified, and are often destroyed. The walls of the cyst become more thickened; between its internal surface and that of the hydatid are deposited layers of a material which appears tuberculous or sebaceous, semi-fluid, sometimes thick and consistent; sometimes, also, there is pus or blood; these concrete in concentric strata (Brückmuller). This deposited matter compresses the hydatic vesicle on all sides, or pushes it against the side of the cyst; its liquid contents diminish, its walls become shrivelled and approach each other, and the cavity finally disappears. Gradually the secreted matter becomes thicker, concretes, assumes the consistency of mastic, then that of chalk, and is at last a calcareous mass. An attentive examination may discover in it membranous shreds of the Echinococcus; but most frequently only the hooks, the chitinous nature of which preserves them from destruction. According to Bremser, Ruysch and several others have made the following observation: 'Finally, the vesicle disappears, and the hydatid is transformed entirely into a calcareous mass, which may sometimes be detached as readily as the healthy hydatid, from the organ in which it is found.'

The *multilocular Echinococcus* is characterized by the restricted dimensions of its vesicles, by the frequent sterility of these, and by their agglomeration into colloid tumours, which have been compared by Guillebeau to a head of cauliflower. The stroma forming the framework and the envelope of the tumour does not undergo transformation by softening, which is usual in the multilocular Echinococcus of Man, and the connective matrix has not acquired the same importance. The hydatid is surrounded by a layer of irregularly cubical giant-cells, from 50 μ to 60 μ in diameter, with numerous peripheral nuclei; and external to these are several rows of round epithelioïd cells. These pseudo-tubercles are united into one conglomerate tubercle by a layer of connective fibrous tissue. At some points the giant-cells are replaced by radiating fusiform cells. Sometimes there can be seen a single giant-cell, which envelops a hydatid (Guillebeau).

Symptoms.—The signs that indicate the presence of Echinococci in the liver of the *Ox* are varied and obscure. They are more perceptible if the lungs are also invaded by the same parasites, and their existence in the liver may then be suspected by some symptoms which now manifest themselves (see *Echinococcosis of the Lungs*).

If the liver alone is invaded, there may be some indications of fever in the respiration, circulation and digestion; but in general these pass unperceived. When the malady is well advanced, appetite and rumination become irregular, and all the more so as the case is serious. The animal wastes, the skin is dry, and the coat dull and staring. Pressure and percussion on the last four ribs of the right side cause pain, and produce a dull sound. Sometimes there is an icteric tint of the conjunctivæ, and obstinate diarrhœa. Rectal exploration sometimes discovers the liver enormously enlarged, and this gives rise to suspicion of the cause.

In the *Sheep*, the same vague symptoms accompany hydatids of the liver; there is feebleness, dulness and indifference, though these may not be very marked, except at the last stages of the malady, when the animal is altogether cachectic. Other symptoms are recurrent tympanites, and pruritus at various points; the wool is dry and brittle, and easily pulled out; and, in general, the symptoms are confounded with those of distomiasis, which may coexist with hydatid disease.

No particular symptoms have been mentioned as betraying the existence of echinococcosis of the Liver in the *Pig*; they should be somewhat the same, however, as those observed in the Ox and Sheep.

There is no need to notice the symptoms that result from rupture of the hydatids of the liver, and discharge of their contents into the peritoneal cavity, as this eventuality, which is not exceptional in Man, does not appear to have been observed in animals.

The disease rarely terminates in death, and most frequently is only discovered after the animal has been slaughtered at the abbatoir.

Etiology.—The essential cause of Echinococcosis is evidently related to the proximity of Dogs, which harbour the *Tænia echinococcus* in their intestine; but it may be aided in its effects by secondary circumstances.

Geographical Distribution.—Echinococcosis appears to be cosmopolitan in the Dog itself, according to the statistics relative to Man. Similar investigations have not been made with respect to animals, but we may conclude that hydatids are much more frequent in them than in our own species. Of the whole of Continental Europe, Mecklenburg appears to be most infested by Echinococci—in some districts they are found in 26 to 50 per cent. of the Oxen, 75 per cent. of the Sheep, and 5 to 8 per cent. of the Pigs, while Man pays a larger tribute to them than elsewhere.

Bollinger states that in Southern Germany echinococcosis is the most common endoparasitic malady of Ruminants, after tuberculosis and distomiasis; and Schmidt estimates the annual money loss it causes in Prussia at 200,000 francs (Friedberger and Fröhner).

But Iceland is beyond all other countries in this respect—a circumstance due to the considerable proportion of Dogs and Ruminants there. Krabbe estimates the number of Dogs at 15,000 to 20,000 to a human population of about 70,000; and we have seen

that these dogs are infested with Tænia echinococcus in the proportion of 30 per cent. Sheep are in the proportion of 488 and Cattle 36 to every 100 people. Men, Dogs and Cattle live in close promiscuity—at least, in winter—and reciprocal infestation is therefore assured. Echinococci are very frequent in the human species, and still more so in the domesticated herbivora. Ewes and Cows are more often infested than the males, and to such a degree does this occur that it is quite exceptional not to find them in Ewes four years old, or in Cows which have reached ten years. Finsen attributes this greater frequency to the fact that Ewes and Cows graze about the houses during summer, and are in this way continually in contact with the Dogs ; while the Sheep and Oxen are driven to the mountains in the spring, and remain there until the autumn. Hjaltelin states that hydatids occur in more than every fifth Sheep in Iceland ; that they have been seen there in every third Sheep over three years old ; and that in one district they are found in every adult Sheep. He also states that one-sixth to one-seventh of the population suffer from Echinococcus. When the animals are killed to put their flesh in salt, the viscera are thrown away and not buried ; on these the Dogs feed, and so become infested with the parasite.

In India, where Dogs are very numerous, 70 per cent. of the Cattle are affected with echinococcosis of the liver. In other parts of Asia, the disease is probably as prevalent in animals, and proportionately so in Man. In Eastern Siberia it would appear to prevail even to a larger extent than in Iceland ; for Kaschin asserts that in nearly all the *post-mortem* examinations he had made of Buratis—a Mongolian people who live there—he found hydatids in the liver and heart. The accounts which are given of the mode of life and customs of this nomadic race give a clue to this grave infestation. In unfavourable weather, for example, and particularly in winter, they live in the same tents or ' yourts ' as the Cattle and Dogs, and in the most loathsome state of filth and uncleanliness ; since they wash neither their dishes nor their own bodies, and wear their clothing until it falls to pieces. Like the Icelanders, they allow the Dogs to clean their wooden dishes by licking them. Australia is infested with echinococci to nearly as serious an extent as Iceland, according to the reports of J. D. Thomas.

Treatment.—Owing to the difficulties attending diagnosis, and the slight disturbance to health caused by the hepatic Echinococci, this disease has not received much attention hitherto, so far as curative treatment is concerned. But prophylaxis is very important. It would be absolute if the Tænia echinococcus could be destroyed ; and this would be effected if Dogs were not allowed to eat viscera containing, or suspected to contain, hydatids, and were submitted to periodic anthelmintic treatment—this is a matter for shepherds and butchers to attend to.

With regard to the prevention of the introduction of the ova of the Tænia into the digestive canal of Oxen, Sheep or Pigs, this can be effected by not permitting them to graze on pastures where Dogs

have deposited their fæces, nor to give them forage suspected of having been soiled by these animals; but this is in practice almost impossible.

ARTICLE III.—Distomiasis (or Fascioliasis) of the Liver.

The term *Distomiasis* (Wiame) or *Distomatosis* (Zundel) designates any affection due to Distomata. *Fascioliasis* has also been employed in England, the parasite being named by some authorities the *Fasciola hepatica*.

The principal species of Distomes of the domesticated animals live in the liver, and the hepatic form is therefore the most important of the Distomiases. In the first line is placed that which is produced in the herbivora, and especially in the Sheep, by the *Distomum hepaticum* and the *Distomum lanceolatum*.

1. THE DISTOMIASIS OF THE HERBIVORA.

The distomiasis of herbivora has been known for a very long time under numerous designations, which have been applied almost exclusively to the ovine species. Chabert enumerates not less than 75. The principal of these are: *Cachexie aqueuse, Pourriture, Bête pourrie, Mal he foie, Foie douvé, Douve, Douvelle, Jaunisse, Bouteille, Boule, Gamadure, Gouloumon, Ganache, Phthisie vermineuse du foie* (Fromage de Feugré), *Cachexie ictéro-vermineuse* (Röll), etc.; in Germany, *Leberfäule, Egelfäule, Leberegelkrankeit, Leberegelseuche, Anbrüchigkeit*; in England, *Rot, Rot-dropsy* (*Fascioliasis, Liver rot, Fluke disease, Cachexia aquosa verminosa*); in Italy, *Bisciuola, Marciaja*; in Holland, *Hot ongans*.

The Distomes of the liver have been recognised for a long time, but the first mention of them is due to Jean de Brie—1379; they were known in France by the name of *douves*—a designation still applied to them every day. A long time afterwards—1547—Gabucinus spoke of worms resembling pumpkin-seeds, as inhabiting the liver of Sheep and Goats, and in course of time other observers made the same remark. Davaine has given an excellent *résumé* of the history of these worms. From an early period, the disease caused by *Distomata* was known in England as 'Rot,' while the parasites themselves were and are alluded to as *Flukes*, from their resemblance to a flounder.

Etiology.—The essential agents in the production of Distomiasis are the *Distomum hepaticum* and, secondarily, the *Distomum lanceolatum*.

DISTOMUM HEPATICUM (Linn.).—Body flattened, foliaceous, of an irregular, pale-brown colour, and 18 mm. to 31 mm. long, by 10 mm. to 13 mm. broad, in the adult; oblong oval or lanceolated in shape, broader and rounder in front, where it suddenly contracts to form a kind of conical neck; attenuated and obtuse behind. Cuticle studded with numerous small prickles directed backwards. Oral sucker terminal, small, and round; ventral sucker large and salient, with a triangular opening, and situated 3 mm. behind the first. Intestine with two ramifying branches—sub-genus

Cladocœlium—visible through the integuments, and of a dark hue. Penis salient, in front of the abdominal sucker, and always curved. Vulva very small, and situated beside the male opening or a little behind it. Ova brown or greenish-yellow, and ovoid in shape, measuring 130 μ to 145 μ long, and 70 μ to 90 μ broad.

DISTOMUM LANCEOLATUM (Mehlis).—Body semi-transparent, speckled brown by the ova, and 4 mm. to 9 mm. long and 2·5 mm. broad; lancet-shaped, obtuse behind, attenuated in front, where it is terminated by the oral sucker, which is nearly as large as the ventral. Integument smooth. Intestine has two non-ramified branches—sub-genus *Dicrocœlium*. Penis long, and generally straight. Genital openings very near each other. Eggs ovoid, and 37 μ to 40 μ long.

HOSTS.—The *Distomum hepaticum* is, above all others, a parasite of Ruminants, in the liver of which it is very often met with—such are the Sheep,

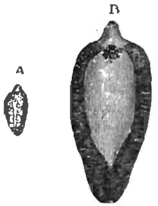

FIG. 271.—*Distomum hepaticum*; natural size.—Railliet.
A, young specimen; B, adult.

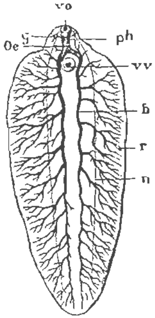

FIG. 272.—Digestive apparatus and nervous system of the hepatic Fluke; the nervous system is diagrammatic.*

* *vo*, buccal sucker; *vv*, ventral sucker; *ph*, pharynx; *oe*, œsophagus; *b*, branches of the intestine; *r*, their ramifications; *g*, nerve ganglia; *n*, ventral nerve.

Goat, Camel, and a certain number of wild species. It is found, besides, in several other domestic and wild animals—the Horse, Ass (Buffalo), Pig, Elephant, Rabbit, and even in Man.

With regard to the *Distomum lanceolatum*, it is generally observed, with the preceding, in the bile-ducts of Ruminants; and it has also been noted in the Rabbit, Hare, Pig, Ass (Sonsino), Dog, Cat, and Man.

GEOGRAPHICAL DISTRIBUTION.—According to Leuckart, *Distomum lanceolatum* is found more often in the South of Europe than in the North, which may be due to differences in the mode of keeping stock, and to the nature of the pastures.

D. hepaticum prevails in the eastern provinces of Prussia (Gerlach), and the *D. lanceolatum* is universally and almost exclusively spread

throughout Thuringia (Zürn), and at Berne (Siedamgrotzky, Guillebeau).

The hepatic Fluke is found all over Europe, with the exception of Iceland. It is very frequent in the Shetland Islands, and it is not rare in the Faroe Islands. It does not appear to have been observed in Asia, has scarcely been seen in Africa, except in Egypt and Algeria,

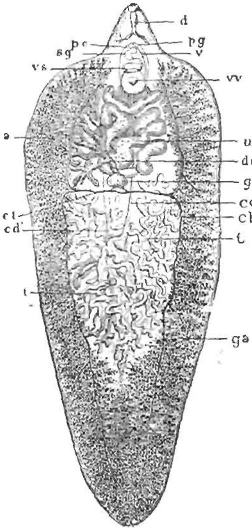

FIG. 273.—Genital apparatus of the Hepatic Fluke.—Railliet.

d, digestive tube; *vv*, ventral sucker; *t*, anterior testicle; *cd*, its vas deferens; *t'*, posterior testicle; *cd'*, its vas deferens; *vs*, seminal vesicle; *sg*, genital sinus; *pg*, genital pore; *pc*, cirrus pouch; *o*, ovary; *do*, oviducts; *gc*, glands of the shell; *ga*, albuminigenous glands; *cl*, longitudinal albuminiferous canal; *ct*, transverse albuminiferous canal; *u*, uterus; *v*, vagina.

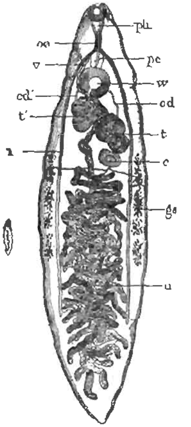

FIG. 274.—*Distomum lanceolatum*; natural size and magnified 10 diameters.—Railliet.

ph, pharynx; *oe*, œsophagus; *i*, branches of the intestine non-ramified and terminated in a *cul-de-sac*; *vv*, ventral sucker; *tt'*, testicles; *cd*, *cd'*, deferent canals; *pc*, pouch of the cirrus; *o*, ovary; *ga*, albuminigenous glands; *u*, uterus; v, vagina.

and it is common in South America, less so in North America; while it is often witnessed in Australia and Tasmania. It causes most serious losses in Australia, into which country it was supposed to have been introduced in 1855, by imported Rams sent from Germany

to Victoria. It is known in India, and has been found in the Buffalo in that country; while a different species has been met with in the Elephant. According to Hamont, the annual fall of the Nile causes the loss, from 'Rot,' of 160,000 Sheep. In Burmah, Sheep husbandry has been found impracticable because of its ravages.

D. lanceolatum has almost the same distribution. It appears to be absent from England, but is found in the other parts of Europe, in Siberia, and in the region of the Amoor (Manchuria), as well as in Algeria and North America.

INFLUENCE OF SPECIES.—Notwithstanding the dissemination of these two species of parasites, distomiasis scarcely exists as a special disease except in the domesticated Ruminants. Cadéac has, however, published a very remarkable case in a she-Ass. It is frequent in the Sheep, less so in the Ox and Pig, and still less so in the Horse.

Hertwig's statistics of animals slaughtered at the Berlin abbatoir during the year 1889-90—154,218 adult Bovines, 116,005 Calves, 430,362 Sheep, and 442,115 Pigs—demonstrate the great frequency of distomiasis in Cattle; as 75 to 80 per cent. of the livers of adult Bovines were slightly affected, but the organ itself was condemned as unfit for food—in consequence of the ravages of the parasite—in 31 per 1,000; while it was 9 per 1,000 in Sheep, ·6 per 1,000 in Calves, and ·12 per 1,000 in Pigs. These differences are explained by the larger quantity of food—and consequently of germs—which the Ox ingests in proportion to the Sheep; while Calves rarely go on any but dry pastures, and Pigs rarely graze at all. If Sheep are more frequently affected than Oxen, it is because their lymphatic temperament offers less resistance to the effects of liver invasion by the parasite.

INFLUENCE OF AGE.—Like most of the parasitic maladies, distomiasis finds a more favourable soil in young than in old animals—Lambs, and year or two-year old Sheep paying a heavier tribute to it than adults; and in several of the epizoötics affecting the bovine species, Calves were the first attacked, Cattle two or two and a half years old dying in greater proportion than those of a more advanced age.

INFLUENCE OF HUMIDITY.—The disease generally appears most frequently in an enzoötic or epizoötic form, and is—because of its frequency and the mortality it occasions—a real scourge to agriculture.

A study of these epizoötics shows that they always follow abundant and prolonged rains, the influence of humidity constantly holding a predominant position in their etiology, as might have been anticipated from what has been said with regard to the migrations of the Distomes. We will borrow from Delafond, Reynal, and Davaine a *résumé* of the principal of these epizoötics.

'The first epizoöty mentioned in history is that which appeared in Holland in 1552, and which Gemma named *lues infanda pecoris*.

'Fromann, in 1663, 1664, and 1665, observed in the Duchy of Coburg an epizoöty that attacked Sheep of all ages, Calves and Heifers up to two years

old, but no Oxen or Cows. The Hares and Deer in the woods and pastures died of this malady, and Horses, Goats, and Pigs were not exempt. Worms were found in the liver of the diseased animals; in four sheepfolds containing altogether more than 3,000 Sheep, there scarcely remained 40.

'In 1674, an affection also characterized by the presence of the Distome in the liver was observed by Willins in Seeland; it attacked nearly all the animals' (Davaine).

In 1743 and 1744, the Rot carried off nearly all the Sheep in the territory of Arles, and in 1761 all the flocks in Aveyron.

In 1761 and 1762, this disease decimated the Sheep in the North of France, and especially in Bas Boulonnais. These two years were remarkable for the heavy rainfall, particularly in summer, all the valleys being inundated.

In 1809, the greater part of France was ravaged by this disease, especially the Beaujolais and Lyonnais. The Sheep constantly fed in the sheepfolds were generally preserved.

'In 1812, the disease prevailed in the Midi, and principally in the departments of the Rhone, Herault, and Gard; 300,000 Sheep perished in the Arles territory, and 90,000 in the arrondissements of Nîmes and Montpellier.

'In 1816 and 1817, it again caused great destruction in many departments of France.

'In 1820, it reigned with intensity in the environs of Beziers.

'In 1829 and 1830, it caused destruction in the majority of the localities in the department of the Meuse and the neighbouring departments, and not only the Sheep, but also the Oxen, perished in large numbers. In the arrondissement of Montmédy, of 24,000 or 25,000 Cattle about 5,000 were lost; of the Sheep, scarcely a moiety remained. Certain communes lost 200 Cattle and 1,500 to 1,800 Sheep' (Davaine). In the arrondissement of Verdun, of 20,000 to 21,000 Cattle, 2,200 succumbed, and of about 50,000 Sheep, nearly 20,000 were carried off by the Rot.

'In 1853 and 1854, the disease again prevailed in the greater part of France, and principally in the departments of the centre; in Berry, Gâtinais, and Sologne, the farmers lost a fourth, a third, and three-fourths of their flocks.

'In England, according to Simonds, great outbreaks occurred in the years 1809, 1816, 1824, and 1830' (Davaine.)

In 1830, the disease carried off in England about two millions of Sheep; the following year there were 5,000 less, weekly, in the Metropolitan markets.

In 1862, it prevailed so violently in Ireland that 60 per cent. of the Sheep were destroyed.

During 1876, Slavonia lost 40 per cent. of its Cattle from distomatosis.

According to Zundel, the disease killed one-third of the Sheep in Alsace-Lorraine, representing a value of 1,500,000 francs.

Wernicke reports that in 1882, in the southerly provinces of Buenos Ayres, this malady killed not less than a million of Sheep. In the one district of Tandil, more than 100,000 succumbed during the first eight months of 1886, *some breeders having lost nearly all of their flocks of 6,000 to 8,000 head each.*

Youatt estimated that, in Great Britain, more than 1,000,000 Sheep annually die of distomatosis. In 1879, England is supposed to have lost about 3,000,000 Sheep, although ten counties did not record any fatality, either because they were free from the malady or did not suffer more than usual. And the loss was put down at the same number in 1880. It has been remarked that epizoötics of unusual magnitude occur about once in every ten years.

Australia would appear to be as severely, and is certainly more constantly, visited by this scourge than Great Britain, the losses being often enormous. In 1891 the destruction was very great, one owner alone having lost more than 10,000 Sheep.

Other considerations also demonstrate the influence of humidity in the development of distomiasis. Thus, it is rare in summer, but prevails with intensity in autumn, at the end of winter, and more

especially in the springtime—during the months of March, April, and May.

It is most severely experienced in low-lying, damp, marshy localities, in valleys liable to be inundated, in the neighbourhood of ponds and stagnant water, at the estuaries of rivers, in wooded localities, and on lands the soil or subsoil of which is clay and impermeable. It is present in an almost enzoötic form in Sologne, Berry, Gâtinais, in the argillaceous zone of the landes of Gascony, and in numerous parts of England, where it kills off a million of Sheep every year. It would appear that no country is free from its invasions.

Inundations naturally play an important part in this etiology. The epizoöty observed in 1761 and 1762 in the Bas Boulonnais was due to this accident; and that which ravaged the South of France in 1810, 1811, and 1812 followed the overflowings of the Rhone and its affluents. According to Hamont and Fischer, the disease appears every year in Egypt after the overflowing of the Nile, and declares itself successively in the places first freed from the floods; they estimate that 16,000 Sheep die every year from it. The illustrious Bakewell, having remarked that, at the commencement of the malady, fattening occurred more rapidly, purposely gave it to sheep intended for slaughter, by placing them for some days during the autumn on pastures which had been flooded during summer.

Certain very remarkable facts, in which humidity was only noticeable, markedly indicate the intervention of the parasitic cause.

Dupuy has seen 500 Sheep die of Rot, which had grazed on damp land, where there were ponds full of stagnant water; but fifteen, which could not accompany them to this place because of lameness, remained healthy.

'A farmer in the neighbourhood of Wragby, Lincolnshire, brought twenty Sheep to the fair, and left six at home. The twenty, not having been sold, were brought back and pastured along with the six, and in the course of the following winter the former died of Rot; but those which had not left the farm continued well. There could be no doubt as to the correctness of the fact, as the Sheep sent to the fair were marked, but the others were not; and the loss of the twenty could only be ascribed to the supposition that they had passed through some district or pasture-land where they acquired the germs of the malady.

'A Sheep belonging to a lot of twenty having broken its leg on leaving the fair of Burgh, Lincolnshire, the remaining nineteen were parked in a pasture at the end of the town until a conveyance could be procured to carry the injured one. These nineteen Sheep died of Rot, but the damaged one escaped' (Davaine).

Development and Metamorphoses of the Distomes.—For a long time our knowledge of the etiology of distomiasis was confined almost entirely to what has just been stated. Several observers—Creplin, Ercolani, Baillet, and Leuckart, among others—were successful in hatching ova of the Distomum hepaticum, but could not effect the transformation of the embryo in its cercarigerous sac after encystment in a mollusc. So that they were reduced to the most plausible supposition, among others, that for this species the

migrations and metamorphoses are analogous to those of the other Distomes. It is to be remembered that Spinola asserted he had developed distomiasis in a healthy (?) Sheep, in causing it to ingest undetermined molluscs collected on infected pastures. The researches of Leuckart and Thomas have, however, dispelled very much of what was obscure.

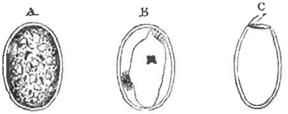

FIG. 275.—Ova of *Distomum hepaticum*; magnified 130 diameters.

A, ovum from the bile-ducts of a Sheep; B, ovum containing a developed embryo; C, an ovum after being hatched.

According to Ercolani, neither ovulation nor hatching takes place in winter; but Leuckart asserts that he has seen ova at all seasons of the year in the gall-bladder of infested animals. It was only exceptionally that he found—particularly in winter—Flukes in which the uterus was nearly free from ova. The ova pass into the intestine like the bile—some directly, others after remaining for a variable period in the gall-bladder. They are produced in enormous quantities in animals which are much infested, Thomas estimating that 200 Flukes will yield 7,500,000 ova. These ova do not undergo

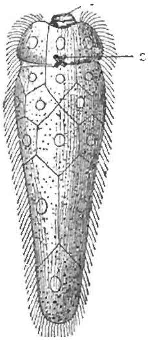

FIG. 276.—Free and ciliated embryo of *Distomum hepaticum*.—Leuckart.

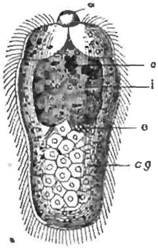

FIG. 277.—The same contracted, with the trace of the digestive canal and a mass of germinative cells.—Leuckart.*

* *a*, perforating apparatus; *o*, ocular spot; *i*, digestive canal; *e*, ciliated funnel; *cg*, germinative cells.

segmentation, and only develop their embryo when they have arrived in the bile-ducts, in the intestine of their host, or—which is most frequent—when they have found their way into water after being

expelled along with the fæces. In summer, the embryo is completely formed in about three to six weeks (Leuckart, Baillet, Ercolani); according to Thomas, it does not arrive at this state unless the surrounding temperature is from 23° to 36° Cent. It then makes its escape by raising an operculum at one end of the shell (Fig. 275, C).

This embryo is not unlike certain Infusoria—infusoriform embryo. It is elongated, attenuated behind, and broader in front. Capable of modifying its dimensions, it has an average length of 130 μ, and is 27 μ broad at its anterior part, at the summit of which is a small papilliform eminence—a kind of rostrum that acts as a perforating, retractile, and protractile apparatus, according to Baillet. All the body is limited by an ectoderm of polygonal cells, and covered by long vibratile cilia, except on the rostrum. A short distance from the latter is seen an opaque pigmentary spot, formed of two lobes that make an *x* in shape, which Leuckart regards as an ocular spot, and which Baillet has seen to effect movements of expansion. Immediately behind the rostrum is a granular mass which Thomas and Leuckart regard as a rudimentary digestive apparatus. The remainder of the cavity of the body is filled by very granular cells. This embryo moves about in water with great agility; but if it does not meet with a suitable host it soon dies. Thomas states that its free phase rarely exceeds an entire day, although he has seen it live for three days in an alkaline fluid.

For a long time the intermediate host, into which the embryo of the Distomum hepaticum must pass, was unknown, and only some species of terrestrial or aquatic molluscs were suspected. Weinland was the first to discover the species so vainly sought for, in the *Limnæa truncatula* Mull. (*L. minuta* Draper).

This is a pulmonary Gasteropod, with a thin, spiral, shining shell, of a pale, horny, ash-grey tint, dextral, acutely spiral, composed of five or six convex turns, the last of them being large, a little expanded, and alone forming two-thirds of the entire shell; summit pointed; opening wide, being nearly one-half the height, obliquely oval and slightly angular superiorly; the margin of the opening—peristome—thin, sharp, the external border straight and reflected outwards; height 6 mm. to 10 mm.; diameter 3 mm. to 5 mm.

This species is found over almost the whole of France, and in nearly all the countries of Europe. 'It lives in basins, ponds, ditches, rivulets, drains of pastures, and loves to leave the water.' It is one of the species that lives on the highest mountains. Pluton has met with it on the Vosges at an altitude of 1,150 mètres. 'I have seen it in the Pyrenees at nearly 1,200 mètres,' says Moquin-Tandon. It is, in fine, a very cosmopolitan species. It inhabits the whole of Europe, Russia, Lapland, Siberia, Afghanistan, Thibet, the territory of the Amoor, Morocco, Algeria, Tunisia, Abyssinia, the Canary and Faroe Islands, and Iceland. It has not been found in Australia, nor in America, nor yet in the Shetland Islands, where, nevertheless, the Fluke exists. Its area of distribution does not quite agree with that of Distomum hepaticum, so we must conclude

that this parasite can complete the primary phases of its development in several species of Molluscs, only one of which is actually known; or that, because of its minuteness, the *Limnæa minuta* has escaped notice in several countries. Perhaps the *Limnæa humilis* Say, plays the part of intermediate host, for this Trematode in North America, and the *L. viator* d'Orb, in the Argentine Republic—these being species which are scarcely distinct from it.

Weinland has found the liver of the *Limnæa truncatula* full of the Rediæ which contain the Cercariæ covered with spines, as is the cuticle of Distomum hepaticum. Acting on the indications of this authority, Leuckart succeeded in obtaining the encystment of the embryo in individuals of this species. He also succeeded with young specimens of the *Limnæa peregra* Gm.; but in these the development stopped in its first phases. In the *L. truncatula*, on the contrary, it may be followed to the formation of the Cercariæ, as has been done by Weinland and Thomas. Experiments made with other species of Limnæa, Planorbis, Paludina, Limacina, Ariona, etc., have failed.

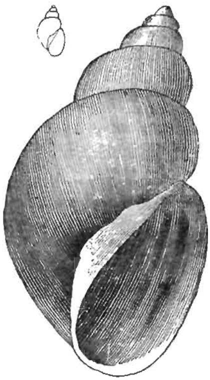

FIG. 278.—*Limnæa truncatula*; natural size and magnified. —Railliet.

As soon as the embryo of the Fluke meets the mollusc suitable to it, it attacks it by means of its rostrum, which is provided in its axis with a kind of semi-rigid rod. It prefers to lodge itself at the bottom of the pulmonary chamber, into which it easily obtains entrance because of its smallness; if it penetrate into the foot of the Mollusc it seldom can pursue its development there, and usually dies in two or three days.

Having arrived in a convenient organ, the embryo loses its layer of ciliated cells, and finishes by contracting into an ovoid mass that grows rapidly. The two lobes of the ocular spot separate from each other, and lose their semilunar aspect; the rudiment of the digestive tube finishes by disappearing; a cuticle replaces the ciliated cells, and the embryo is transformed into a *Sporocyst* (see p. 274). The latter acquires its definitive size—·5 mm. to ·7 mm.—in less than fifteen days during the summer, and in about a month in the autumn. The cavity of the body was filled with round transparent cells, named *germinative cells*; these are now disposed as a muriform mass. The very young Sporocysts may sometimes become multiplied by transverse division. The cellular masses are ordinarily five to eight in number, though they may only form one.

These muriform masses (*morula*) are transformed into so many

Rediæ, provided with a simple digestive apparatus. They are cylindrical, and have at their posterior extremity two short, obtuse appendages. The Rediæ in the same Sporocyst appear in several stages of development. When they have attained an average length of ·260 mm. they begin to move energetically, and finally rupture the maternal sac, from which they issue one by one.

On obtaining its liberty, the Redia quits the pulmonary cavity of

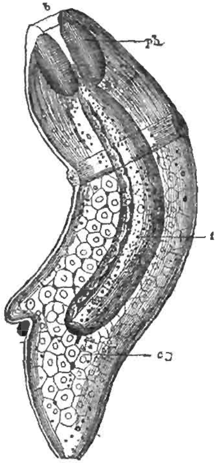

FIG. 279.—Redia of the *Distomum hepaticum*.—Leuckart.

b, mouth ; *ph*, pharynx ; *i*, digestive tube ; *cg*, germinative cells for the production of the cercariæ.

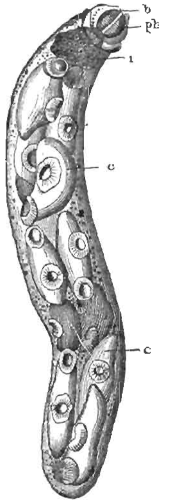

FIG. 280.—Redia containing Cercariæ.—Leuckart.

b, mouth ; *ph*, pharynx ; *i*, digestive tube ; *c*, cercariæ.

the mollusc, passes through the tissues, and fixes itself in another organ, usually in the liver. There it gradually grows to a length of 1·3 mm. to 1·6 mm. The mouth appears at the anterioı extremity, and the digestive tube, as a single *cul-de-sac*, is more distinct ; a circular collar is formed behind the pharynx by a thickening of the cuticle, and represents the oral sucker ; and the secretory apparatus is more markedly developed than in the Sporocyst. The cavity of the body of the Redia forms germinative cells, whence is derived the

morula or cellular mass that becomes transformed into daughter-Rediæ—ten at most—or into Cercariæ, the number of which may be as high as twenty-three.

According to Thomas, the Rediæ engender the daughter-Rediæ during warm weather; in winter they produce Cercariæ. He has seen in the autumn, in the same Redia, a single daughter-Redia developed in the midst of a great number of Cercariæ. In favourable circumstances, a single ovum of the Fluke may in this way produce a thousand Cercariæ.

The daughter-Rediæ or the Cercariæ leave the Redia by a single opening at the side, a little behind the collar. Each daughter-Redia forms from fifteen to twenty Cercariæ, which are evacuated in the same manner.

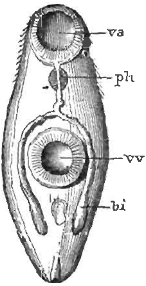

FIG. 281. — Cercaria extracted from its cyst.—Leuckart.

va, anterior sucker; *vv*, ventral sucker; *ph*, pharynx; *bi*, branches of the intestine terminating in the cæcum.

The Cercaria is provided with a digestive apparatus, the intestine of which is divided into two branches. The mouth opens at the bottom of the oral sucker; the ventral sucker—of the same size—is seen on the middle of the inferior surface. The excretory apparatus is recognisable. Particular cells—named *cystogenous cells*—are distributed in large numbers in the lateral part of the body. The latter is oval, flattened, covered with very fine spines, and measures on the average ·28 mm. long by ·23 mm. broad, though it may attain ·30 mm. in length. It is prolonged by a very contractile tail, which is twice as long as the body.

When the Cercaria escapes from the body of the Redia by the hatching orifice, it leaves its host—creeping and writhing among the tissues by means of its suckers and its tail; and on gaining its freedom it swims in the water, moving about energetically, and incessantly modifying its shape and dimensions, eventually fixing itself on some submerged body—such as an aquatic plant, or on leaves of weeds or blades of grass, of damp pastures. The cystogenous cells, expelled from the body, are employed to form a cyst in which the cercaria is enclosed; and its tail disappears either immediately before or after this encystment. The presence of cysts on the leaves of plants is denoted by white points, formed by a kind of mucus accompanied by special granules. The peregrinations of *Limnæa truncatula* facilitate the dissemination of the Cercariæ.

It is, therefore, in consuming the herbage of damp pastures that animals become infested; and this explains why Leuckart was unsuccessful, when he caused Rabbits to ingest Cercariæ which had not undergone encystment. On the other hand, Thomas affirms that the Cercariæ are more especially found on the lower leaves of

plants—those nearest the ground; and it is because of this that Sheep—which cut the herbage close to the ground—are more often infested than Cattle, which do not graze so close. It has long been remarked in England, that Sheep which have the deformity of the mouth known as 'hog-jaw,' or the other deformity called 'parrot mouth' or 'shuttle-gob'—which prevent them cropping the herbage so close as normal-mouthed Sheep—are seldom affected with 'rot.'

The molluscs, with their Rediæ, may also—because of their small size—be swallowed by the herbivora; but this mode of infestation is not very probable—at least, with Sheep, which, when drinking, keep the lips close together, leaving only a narrow slit for the passage of the water. Otherwise, they drink but little when they have access to moist herbage.

The encysted Cercariæ can remain alive on pastures so long as these remain moist; drought throws it into a kind of latent existence for an undetermined period, during which it lies huddled up in its envelope.

When it arrives in the stomach,

FIG. 282.—Embryo of the *Distomum lanceolatum*.—After Leuckart.

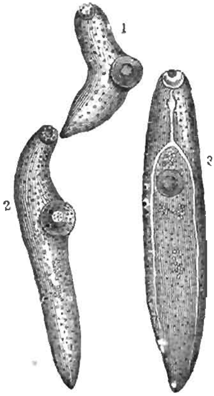

FIG. 283.—Development of the *Distomum lanceolatum* in biliary ducts of the Sheep.—After Ercolani.*

* 1, first phase, no digestive apparatus; 2, ulterior phase, some groups of cells represent the future testicles; 3, more advanced phase, testicles more distinct, and above the ventral sucker is a group of cells marking the future cirrhus pouch.

the cyst is dissolved, and the parasite is set at liberty and penetrates the liver, probably by the ductus choledochus.

The telluric conditions that influence invasion of the liver of Sheep by *Distomum lanceolatum*, do not differ from those that rule in the case of *Distomum hepaticum*; but the evolution of the first of these two species is still unknown. Contrary to what occurs with *Distomum hepaticum*, the ova of *D. lanceolatum* undergo segmentation and develop their embryo in the maternal intestine; but the latter is not hatched until after a sojourn of three weeks in the water.

When set free it is globular or pyriform in shape, and ciliated only on the anterior third of the body; it is therefore less active than that of the *D. hepaticum*. It is armed with a sharp protractile and retractile cephalic needle. Willemoes-Suhm believes he obtained its encystment in the *Planorbis marginatus*. Representatives of this mollusc having been placed in an aquarium, the water of which had been sown some months previously with the ova of *Distomum lanceolatum*, were found afterwards to be bearers of Cercariæ (*Cercaria cystophora*). This Cercaria—previously described by G. Wagener—derived from a Redia coming itself from a Sporocyst, is remarkable for possessing two unequal tails. Leuckart believed he had developed the *D. lanceolatum* in a Sheep to which he had given the *Cercaria cystophora*; but he has since repeated the experiment without success. Ercolani asserts that the young *D. lanceolatum* shows no traces of digestive apparatus, and cannot therefore be derived from the *Cercaria cystophora*, which has one. Lastly, Creutzburg—a pupil of Leuckart—has demonstrated that this Cercaria is that of the *Distomum ovocaudatum*, which is not rare beneath the tongue of the green Frog.

Piana, having discovered in the *Helix carthusiana* sporocysts containing the *Cercaria longicaudata*—which has no intestinal tube—has for this reason admitted that it represents the larval state of *Distomum lanceolatum*. But, as Blanchard remarks, the embryo of this Distome—considering its ciliated covering—is necessarily aquatic, and cannot reach terrestrial molluscs.

The question of the migrations and the development of the *D. lanceolatum* belongs to the problems yet to be solved with regard to it.

Migrations of the Distomes.—The infestation of flocks by the larvæ of Distomum may occur at any period of the year (Bollinger, Schaper), as the night frosts do not destroy all the Cercariæ (Friedberger). Nevertheless, heat being very favourable to the development of the ova, it is more especially during the summer and autumn, up to the first frost, that infestation takes place. It may occur very rapidly; for instances are recorded in which sojourn for less than half an hour on an infected pasture has been sufficient. In general, however, it occurs in an insidious and progressive manner, though successive invasions may be manifested on the same animals, or a flock may submit to repeated invasions in distinct groups.

No observer has been able to note the precise moment when immigration of the Flukes occurs. Joseph says he has found, on several occasions, small Cercariæ without tails in the duodenum of the Sheep. But there is nothing to prove that these were young Distomes in process of being prematurely evacuated.

The majority of the Distomes remain in the bile-ducts; but some pass through their walls, into the hepatic parenchyma, excavate and destroy it, and perforate Glisson's capsule and the peritoneum, and so give rise to perihepatitis or peritonitis. Others reach the roots of the vena portæ and there set up endophlebitis, thrombosis,

and embolism; while a small number may enter the sub-lobular veins and thence travel into the most distant parts of the body. In consequence of its proximity, the lung is the organ in which these wandering Flukes are more frequently met with; but they have also been seen in the muscles and connective tissue. Leuckart admits that they arrive there in leaving the venæ cavæ; while Friedberger entertains the more plausible opinion that these are distomes of the lungs which have passed into the pulmonary veins, when the blood-stream carries and disperses them. Gerlach attributes the fatal apoplexies sometimes observed in the first stage of distomiasis, to cerebral embolism produced by the young Flukes.

The Flukes commence to quit the bile-ducts to pass into the intestine as soon as their reproductive organs are completely formed —which, according to Leuckart, takes place in about three weeks. As it is in May and June that there are sometimes found in the fæces Distomes generally very much altered by the intestinal juices, Gerlach allows that their emigration always takes place about this time, and that these worms never exceed the age of nine to twelve months. Pech and Friedberger have found numerous Flukes in the gall-bladder and duodenum in the autumn and winter. Thomas has observed these parasites in two Sheep fifteen months after the period of infestation. The statistics of cases of distomiasis noted by Hertwig in the Berlin abattoir, show that it prevails at all seasons of the year, but more frequently in October and in the springtime— a circumstance that corresponds exactly with its etiological conditions.

Symptoms.—By its symptomatic physiognomy, distomiasis of the Sheep is a pernicious anæmia, and justifies the name of 'cachexia' so often given to it. Otherwise, the signs of the malady have nothing pathognomonic in them, and might be mistaken by many for those of the various helminthiases of this animal. In the course of the distomiasis, Gerlach recognised four periods or stages, based on the varied relations that the Flukes contract with the liver of their host. Very often these periods are not distinct from one another, owing to the repeated infestations obscuring them; but they, nevertheless, give a good idea of the progress of the malady.

1. *Period of Immigration.*—This period corresponds to the fall of the year, and generally passes unperceived, as the lesions the young Flukes have produced in the liver have scarcely had time to affect the general health of the animals. The cases of death from cerebral apoplexy, remarked upon by Gerlach, occur at this period, the duration of which varies from four to thirteen weeks and more.

2. *Period of Anæmia.*—This coincides usually with the months of September and November. The Sheep are less lively, and the visible mucous membranes, the inner surface of the ears, and the skin generally, are paler than in their normal state. But the appetite is still good, and the animals have a tendency to fatten more readily, as Bakewell had remarked; and this may be due—according to Simonds—to the stimulus the young Flukes impart at first to the

liver, and consequently there is a more abundant biliary secretion and better assimilation. But soon the appetite diminishes, the thirst increases, and rumination becomes irregular; the mucous membranes and the nude skin are of a dull white, slightly yellowish hue. There is slight œdema; the skin is more supple and in parts doughy, the fat regions being soft; the conjunctivæ are infiltrated and puffy, no longer show their vascular network, and form a circular, salient, whitish-yellow ring when the eyes are explored by separating the eyelids and gently pressing between the thumb and index-finger; this appearance causes the shepherds and butchers to say the animal has a *fat eye*. The wool becomes dry, brittle, easily pulled out, and falls off spontaneously in places; debility gradually becomes more marked; the Sheep allow themselves to be easily caught, and scarcely struggle when seized by the hock; this muscular weakness is perhaps most manifest in Sheep still fat, and it is sufficient to enable the butchers to recognise the malady. There is sometimes fever and quickened respiration. Palpation and percussion indicate ascites. The fæces are normal, but at the end of this period they contain numerous Fluke ova.

3. *Period of Wasting.*—Its commencement corresponds to about the end of the third month after the immigration of the larvæ—that is, generally towards the beginning of January. The disease then reaches its maximum.

Emaciation—at first not very marked—makes considerable progress. The mucous membranes and skin are blanched, but have no icteric tint, though Trasbot says he has often seen icterus lead to the speedy death of fat Sheep ready for slaughter. The temperature is variable, and is marked by a very irregular curve, its maximum being sometimes shown in the morning, sometimes in the evening. The respiration is laboured and quick; the appetite is still maintained, and defecation offers nothing unusual except in the numerous ova of the parasites in the fæces; the urine is about normal. The animals are languid and dejected, with their head carried low, and pressure on the back causes them to fall. With pregnant ewes abortion is frequent, and those which are suckling have watery milk, while their lambs are puny, and generally die if they do not have another nurse. The œdema remarked in the preceding period is localized, and is most perceptible at the dependent parts of the body; it disappears with exercise and reappears with rest. Œdema is noticed in the submaxillary space, and it extends gradually below the larynx, and over the cheeks and parotids. The shepherds in France call it *bouteille*, *bourse*, *boule* (bottle, purse, ball; in England the Sheep is said by shepherds to have the 'watery-poke' or to be 'chockered'), and they rightly consider it one of the most characteristic symptoms of the malady. The 'bottle' disappears at night while the animal is resting in the sheepfold, and re-forms again while it is grazing, owing to the dependent position of the head and neck; it is often absent in adults, and during warm weather. In the three following weeks, emaciation

is still more noticeable, notwithstanding an abundance of food; but, as a rule, there is neither œdema, icterus, nor indication of pain on pressure in the region of the liver. Death often occurs at this period, though animals are rarely allowed to live so long. In other instances amelioration takes place, and the Sheep reach the next phase.

4. *Period of Emigration of the Flukes.*—This is the period of convalescence and spontaneous recovery, shown by progressive abatement of all the symptoms, and it corresponds, according to Gerlach, to the months of May and June, though it may occur earlier. But recovery is never complete, the lesions in the liver being irreparable.

The duration of the malady is very variable, and depends upon the degree of infestation, the temperament of the animals, and the conditions of hygiene to which they are submitted. Most frequently the duration does not exceed six months, and exceptionally it may be very rapid. Bonvicini has seen two Sheep, in which the parasites had induced acute hepatitis, die, one on the seventh, the other on the ninth day after the appearance of the first symptoms.

Complications frequently occur in distomiasis. The enfeebled economy is predisposed to numerous affections, and especially to those of a parasitic nature—such as scabies, 'gid,' verminous bronchitis, and intestinal helminthiasis. These of themselves prepare the soil for distomiasis, and the coincidence of these various parasitic disorders accounts for the opinion of those who do not recognise the autonomy of distomiasis, but include it in a general helminthiasis.

Diagnosis.—The diagnosis of individual cases may present some difficulty. But it is assured when a microscopical examination of the fæces results in the discovery of the Fluke ova in them. It is a long time since Davaine pointed out the value of this element in diagnosis, and Bunck was the first to have recourse to it; he estimated the number of ova in 500 grammes of fæces at from 1,000 to 3,000. According to Perroncito, there is found on the average an ovum in each microscopical preparation when the liver contains 85 Flukes, and 10 ova for 800 Flukes; but Brusaferro's figures do not accord with these, as his researches showed that if—in infested Sheep—the ova of Flukes are always found in the excrements, their number by preparation is not always in proportion to that of the parasites in the liver, the relation between them varying from 1 to 13 for every 100 flukes. In certain grave cases thirty may be found in each preparation. Otherwise, the number of ova may also vary according to the time of day when the fæces are passed, this variation being no doubt due to the differences in activity of the biliary secretion, which will carry into the intestine a more or less large number of ova. On the other hand, the ova of the *Distomum lanceolatum* are relatively rare, and the search for them may be fruitless, although the number of parasites may be high.

The ova of the Distomes present the features already indicated; a magnifying power of 70 to 80 diameters is sufficient for their search;

and their presence in the fæces is almost the only sign which permits distomiasis to be distinguished from simple dropsy—though it has been stated that 'Flukey' Sheep are yellow about the eyes, while the dropsical ones are not so; that the feebleness of the latter keeps them quiet, and that the 'bottle' is most frequently observed in the former. But these differences are very inconstant, and when the disease prevails as an epizoötic in a flock, the nature of the malady is at once discovered by an autopsy of the animals which have died or been killed.

Beattie—an experienced observer—notes that if, in spring, when the Ewes are dropping their lambs, the liquor amnii is very white, and like thin watery bubbles, it is a bad sign; and in September, when drafting the Ewes, he adopts the usual method of feeling the condition. Those in which the lumbar muscles feel soft and flabby, and in which the extremities of the lumbar transverse processes can be readily felt, are considered unsound—they are known as 'lean on the back'; and the impression is conveyed to the fingers of crackling, as though there were water and gas below the skin—'rippling,' as it is termed. Beattie insists that this test is of value only when applied by an experienced man, and that no one can, with absolute certainty, 'draw' a flock tainted with 'rot.'

Prognosis.—The symptoms of distomiasis always indicate a serious affection, as they testify to the presence of a large number of Flukes in the liver; but that which gives a special gravity to the prognosis, is the fact that the disease is rarely confined to a few individuals, but generally affects the whole flock, and greatly harasses rearing operations, as it brings Sheep prematurely to the butcher, and at a heavy depreciation in their value. We have seen above, when dealing with the etiology, how extensive and damaging the epizoötics of distomiasis sometimes are.

Pathological Anatomy.—The fundamental lesions are found in the liver, the others being only a corollary. The first vary according to the period at which the autopsy takes place, and they have been particularly well studied by Friedberger.

1. *Period of Immigration.*—The first effect of the penetration of the Flukes into the bile-ducts is inflammation (*period of traumatic hepatitis*, according to Gerlach). The liver is enlarged, and contains more blood than usual; it is friable in texture, and its surface is smooth, or marked in places by openings the size of a pin's head to that of a millet-seed, from which exudes a sanious fluid on pressure. There are traces of local peritonitis, or of exudations, which cover the young Flukes; and small hæmorrhagic centres exist in the parenchyma. The bile is slightly reddened, and the peritoneal serosity is more abundant, and often contains small Flukes. The fæces do not yet contain ova.

2. *Period of Anæmia.*—The character of the lesions, which have been more particularly described by Friedberger, may be summed up as follows:

Considerable emaciation; localized œdema; serous effusion into

the natural cavities, often associated with recent blood-clots, and fibrinous exudates; adhesions, especially between the liver and peritoneum; loss of transparency and thickening of the parietal serous membrane, which is easily detached from the abdominal walls; tumefaction of the mesenteric, diaphragmatic, bronchial, and intestinal glands; liver notably increased in volume, particularly in thickness. In the majority of cases, the left lobe of the liver is the first to be invaded (Falk, Schaper). The surface of the organ is covered—especially in front—with slightly adherent fibrinous exudate, beneath which are found, in some instances, a number of young Flukes 5 mm. to 8 mm. long; they are even sometimes met with in the abdominal cavity. The capsule of the liver is velvety, not smooth to the touch, opaque, uneven, lumpy, and at times covered with calcareous concretions; the parenchyma has a porphyroïd appearance, and has small subserous hæmorrhagic centres and channels excavated by the parasites, and containing—as a nucleus—a small Fluke from 3 mm. to 5 mm. long. Flukes are also met with beneath the serous membrane in different parts; in certain cases there are those which have their oral extremity free in the peritoneal cavity, the capsule being perforated at the corresponding points by openings similar to those observed in the first period. The gall-bladder may or may not contain Flukes, ova not being found in it except when the parasites are adult, and the bile varies in colour between green and deep violet.

The hepatic parenchyma is soft, and the thickened connective tissue slightly grates on section; the surface of the latter is of a dirty grey, yellowish-red, or blood colour, and perforated by spaces the size of a pea, which contain one or more young Flukes in a blood-clot, or in a sanious fluid formed of white and red corpuscles, hepatic cells which have undergone fatty degeneration, and a finely granular *detritus*. The vena portæ sometimes contains a stratified thrombus lodging a Fluke in its centre; or a small vessel may be found occluded by the worm, and a thrombus that extends into the vena portæ. The mucous membrane of the bile-ducts is everywhere tumefied, injected, ecchymosed, and sometimes torn; the epithelium has been removed by catarrhal desquamation, which often assumes a purulent character, and it may have the features of a diffused adenoma; the hyperplasia of the walls of the ducts may intrude on the surrounding tissues, and act in the manner of a destructive adenoma (Bollinger). Over the entire liver the cells are granular, and infiltrated with fat; the connective tissue is in process of proliferation.

3. *Period of Wasting.*—The preceding lesions become accentuated, and assume a chronic character. The emaciation is considerable, the fat having completely disappeared, or if there is any left it is soft, nearly transparent, and yellowish. Beneath the visceral pleuræ—above and behind—are nodules the size of a hemp-seed; erratic Flukes have produced local splenizations and hæmorrhagic centres in the pulmonary parenchyma. Petechiæ beneath the endocardium. Borders of the liver rounded; its two lobes, but

especially the left, are atrophied, and their tissue is firm, hard, and even grates beneath the scalpel. The connective-tissue hyperplasia and the cirrhosis are considerable; and section of the organ has a spongy appearance, due to cavities more or less close together. Glisson's capsule is very granular, in consequence of numerous cicatricial retractions.

The bile-ducts are the seat of a dilatation that augments from their origin towards the periphery, their diameter being about that of a finger, and they are more or less moniliform. The finest canaliculi are dilated to their end, and have there acquired the calibre of canals of the first order. Compression of the bile-ducts causes the expulsion of adult Flukes, among a brownish-green mixture. One canal, particularly in the left lobe, may contain as many as ten parasites.

Thomas remarks that, in some of the small bile-ducts, where the ova have not been floated away by the bile, these may be present in such enormous multitudes as to form a stiff, dark-brown mass, looking like fine, wet sand, and completely occluding the duct. In the earlier stage, when the liver is gorged with blood and bile, and death is frequent from acute congestion of the organ, though no adult Flukes are present, yet careful examination on section will detect myriads of very minute young parasites, which appear on the point of the scalpel as small masses of jelly or inspissated bile. A good observer has stated that young Flukes may sometimes be found in the ducts of the liver as a thick, light-coloured liquor that appears all in motion, and an inspection of this with a pocket-lens confirms the view that the fluid is chiefly composed of immature parasites.

The gall-bladder contains a mucous bile of a dirty, greenish-brown hue, and adult Flukes and ova in great numbers. There are generally observed on the surface of the bile-ducts punctiform incrustations, which may be more extensive—sometimes are even tubular—formed of phosphate of lime, with traces of phosphate of magnesia. At the same time their walls are thickened, and have become cartilaginous. The liver crepitates if it is compressed or incised.

The presence of the Flukes has been regarded as the cause of the formation of biliary calculi; but only two instances in support of this view are furnished by Simonds and Brouisson, who, in such calculi, have found, the one twelve Flukes, the other only one.

4. *Period of Emigration of the Flukes.*—At the autopsy of animals sacrificed during this period, the disappearance of the Flukes is remarked, and also the persistence of the irreparable alterations which the liver has undergone in the preceding periods.

The number of hepatic Distomes the liver may contain is very variable, and is always high when the malady is accentuated. Dupuy has counted more than 1,000 in the liver of one Sheep.

Distomum lanceolatum never produces such serious symptoms or lesions as *Distomum hepaticum*, and it alone cannot produce 'rot.' This relative innocuousness is attributed by Leuckart to its smaller size, and to the absence of prickles on the integument. Otherwise,

the two species are very often found in the same host; but by reason of its minuteness *D. lanceolatum* penetrates the smallest bile-duct, which the other species cannot enter. This is why its number often appears less than it really is, because its presence is sometimes not noticed. Friedberger has obtained thousands from the bile-ducts by compression—these canals were literally swarming with them; they were also found in multitudes in the gall-bladder and intestine at the time of their spontaneous emigration.

The effusions into the serous sacs or the connective tissue should be ascribed to the cachectic state, and to the general alteration in the blood—to its deglobulization—which favours passive effusion. The obstruction to the circulation in the portal system has a large share in the production of these effusions, as there results a transudation of serum throughout all the accessory venous branches, with consequent ascites.

Anæmia is also partly due to the blood extracted by the Distomes for their nourishment. Some authorities are of opinion that Flukes live on the bile; but Leuckart and Küchenmeister are convinced that they subsist on the blood in the mucous membrane of the bile-ducts. An observation made by Railliet confirms this statement. In the liver of a Sheep, the arterial system of which had been injected with coloured plaster, he found a great number of Flukes with their digestive canal also injected with the plaster. That substance had evidently been obtained by suction from the small intact blood-vessels of the bile-ducts at the moment of injection.

Prophylaxis.—Every effort should be made to keep Sheep away from damp pastures, where all the conditions necessary for the existence of the larval forms of Distomata are present. The vigilance of the shepherd is, in this respect, the first element of success.

Thomas has formulated prophylactic prescriptions which, if adopted, would certainly go a long way in limiting the ravages of *distomiasis*.

1. Everything should be done to destroy or render inoffensive the ova of Flukes, and the molluscs which serve as intermediate hosts. This may be effected by the following measures:

a. Destroy the diseased Sheep, and bury them; or do not give their carcases to Dogs until they have been cooked, and only then if there is no reason to apprehend that the ova of the Flukes may pass through the intestines of these animals, to be spread by them over pastures along with their excrements.

b. Only put on dry pastures affected Sheep intended for the butcher, as the Fluke ova they evacuate cannot develop in the absence of humidity.

c. As Hares and Rabbits—which are sometimes bearers of Distomes—may infest pastures, they should not have access to those on which Sheep graze. But this recommendation cannot well be carried out.

d. Drain wet pastures, or, if this cannot be accomplished, dress

them with salt or lime. The latter in solution—·75 per cent.—will destroy Fluke embryos as well as molluscs. With regard to salt, we are indebted to Perroncito for some precise notions as to its action. Ercolani had for a long time observed that water slightly impregnated with salt killed the Cercariæ, and in acting on these and on the encysted larvæ of the *Limnæa palustris*, Perroncito found that in a 2 per cent. solution these parasites died in less than five minutes; in a 1 per cent. solution they rolled themselves up at the end of two to seven minutes, and perished after twenty to thirty-five minutes. The same happened in ·64 per cent. solutions; and in those of ·25 per cent. they were still alive after more than twenty hours. The period when salt or lime should be spread on the pastures should coincide with the time when the embryos of the Distomes and the Cercariæ abound—that is, June and July for the first, and August for the second.

2. If Sheep must be placed on infested lands, the ill effects likely to result therefrom may be much reduced by the following precautions:

a. Do not allow the animals to come too near one another while at pasture, as the closer they are the closer they graze the herbage, and it is on the parts of the plants nearest the ground, according to Thomas, that the Cercariæ prefer to fix themselves.

b. Give every day to each Sheep 7 or 8 grammes of salt, and 230 to 240 grammes of oats. The salt is fatal to the Cercariæ, and favours digestion and assimilation. Perroncito recommends its being put into the drinking water; ·50 per cent. does not render the water undrinkable.

In England for ages salt has been known as a most valuable preventive remedy; and long before its *modus operandi* was understood, the knowledge of its value was probably derived from observation of the fact that Sheep grazed on salt marshes, no matter how humid they were, did not suffer from rot.

Zundel proposed that there should be two feeding-grounds for Sheep in wet seasons, on marshy localities—one pasture for spring grazing to June, the other for autumn grazing. The first, though much infested, would not have convenient hosts for the final phases of development of the parasites, and the frosts of winter would probably free the pasture of the embryos and intermediary bearers; while the autumn pasture would not become contaminated with ova, or these would not find suitable conditions for their development.

Simonds advises the adoption of the following precautions:

The animals must be carefully guarded against all vicissitudes of weather by being folded in the best sheltered situations, more especially at night. The food should consist of a liberal supply of materials which are rich in flesh-forming principles, and which also contain a large proportion of sugar, starch, and similar ingredients, that the heat of the body may be kept up equally with nutrition. If placed on meadows or artificial grasses, the Sheep should be often

changed, care being taken to avoid those pastures which are wet and cold or which contain inferior herbage. Manger food must be supplied, and this should consist, at least, in part of crushed corn, of which beans, peas, lentils, etc., are to be preferred. Oats and maize are also good, and to these a moderate allowance of oilcake may be added. Frequent changing of the food will induce the animals to eat more, for which reason, when they are on pastures, no objection is to be taken to an occasional supply of turnips or other roots; but, unless compelled by the character of the farm and the system of cultivation, continuous folding on turnips should be avoided. Where this has to be done, great care will have to be exercised in regulating the quantity of turnips, according to the condition of the crop, the state of the weather, etc. Under such circumstances, an allowance of good hay, in addition to the other food, will be imperatively required.

A good compound of several medicinal agents, with some highly nitrogenized alimentary matters, is contained in the following formula: Take of finely-ground oilcake (linseed), finely-ground pea-meal, each 1 bushel; finely-ground salt, finely-ground aniseed, each 4 lb.; finely-ground sulphate of iron, 1 lb. Let the salt, aniseed and sulphate of iron be mixed together first, and afterwards well incorporate with the cake and peameal.

The quantity of the mixture to be given to each Sheep daily should be half a pint to a pint, in addition to an ordinary allowance of corn or cake and hay-chaff. It may be used with advantage for three or four weeks in succession, but should be discontinued occasionally for a day or two, especially if the animals become affected with diarrhœa.

Trasbot states that branches of oak-trees, elm, hornbeam, etc., cut in summer and dried with their leaves, are an excellent preventive if given to the Sheep before they are driven to pasture, as well as those of juniper or any other aromatic trees.

Treatment.—All the resources of therapeutics have been tried against distomiasis, but no really efficacious agent for every case has yet been discovered; this is owing to the remote location of the Distomes, which can scarcely be reached by any substance given to the affected animals.

However, if, generally, a cure is not to be expected, it is usually possible to so ameliorate the condition of the Sheep as to enable them to pasture and fatten. This result is obtained by the employment of tonic and astringent preparations, by good feeding, and especially by driving the Sheep away from the infested pastures.

The leaves of wild chicory, tansy-roots, wormwood, pine-leaves, spruce-leaves, walnut-leaves, juniper-berries, willow-bark, oak-bark, infusion of pepper in alcoholic drinks (Teissier and Huzard), Chabert's oil, petroleum, limewater, creosote, benzine (Bunck), picrate of potash, liver of antimony, nux vomica (Prinz), tincture of iodine De Romanet), asafœtida and garlic (Vallada), soot (Raynaud), etc.,

are agents which have been apparently successfully employed, but most frequently they are inconvenient.

Various salts of iron and culinary salt, dissolved in the drinking water or mixed with the provender, have with more reason been recommended by all authorities.

Trasbot asserts that the young dried buds of maritime pine-trees, mixed with bran, produce really curative effects.

The experiments of Perroncito show that the ethereal extract of male fern, given with oil of turpentine, or benzine, castor-oil, wine, etc., kills the Distomes; but it has the inconvenience of causing anæsthesia and serious tympanites, so that before it can be recommended as a safe remedy further trials are required.

Mojkowski has obtained very encouraging results in treating distomiasis and tæniasis in the Sheep, with naphthalin given twice a day for a week, in doses of ·70 gramme to 1 gramme, alone or mixed with gentian powder.

In Germany, recourse is had to lupin forage, then to lupin-seeds, giving about 40 litres per day to 100 Sheep. Crushed barley, roasted malt, linseed-cake, bran, oats, boiled or grilled pods of legumes, hay of good quality, etc., are also given, as *régime*, because of their nutritive properties.

As remedies, bitter tonics, mixed with sulphate of iron, are utilized. The following preparations, recommended by Haubner, enjoy a certain degree of credit:

1. Sulphate of iron		60 grammes.	Dose for 100 Sheep.
Calamus aromaticus		500 grammes.	
Crushed oats	of each	20 litres.	
Roasted malt			
2. Sulphate of iron		30 grammes.	Dose for 50 Sheep.
Powdered juniper-berries	of each	500 grammes.	
Gentian powder			
Crushed wheat		20 litres.	

In France, on several occasions, Gasparin, Rey, and Roche-Lubin have employed anti-cachectic bread, which was given morning and evening to the diseased Sheep. The simplest formula is that of Delafond:

Undressed wheatmeal		1 kilogramme.
Oatmeal		2 kilogrammes.
Barleymeal		1 kilogramme.
Sulphate of iron	of each	30 grammes.
Carbonate of soda		
Culinary salt		200 grammes.

These are made into a paste with water, which is allowed to ferment, and is then baked in an oven. Delafond says that in fifteen days this bread produced a considerable amelioration.

To sum up, the resources of the pharmacy ought not to be relied upon to any extent, but attention must be specially directed to the *régime*, which should be as strengthening as possible.

DISTOMIASIS IN CATTLE.—Distomiasis in bovine animals is manifested by symptoms quite analogous to those observed in Sheep. But they often pass unperceived, because of their less intensity and the stronger resisting power of the larger Ruminants. The coat is dull and staring, the skin tight and adherent, the appetite capricious or *nil*, and rumination is suspended; constipation alternates with diarrhœa, and the urine becomes acid. Serious symptoms only appear later, and the malady rarely terminates in death; when it does, the animals succumb to profound marasmus, extreme emaciation, continuous diarrhœa, and a complete consumption. The duration of the disease is from two to five months. The lesions are those noted in Sheep. The bile-ducts may attain the diameter of an inch, and the liver, consequently, has a vesicular appearance. In the slaughter-house very important hepatic lesions are found in animals which, during life, did not show any sign of such alterations.

Treatment demands the same prophylactic and curative measures as for Sheep suffering from distomiasis.

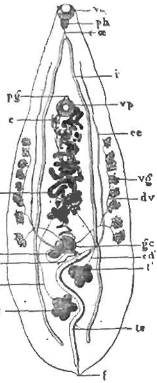

FIG. 284.—*Distomum Conus s. truncatum*; magnified 10 diameters. —Railliet.

va, anterior sucker; *vp*, posterior sucker; *ph*, pharynx; *œ*, œsophagus; *i*, branches of the intestine; *ce*, excretory canals; *t*, their common trunk; *t*, *t'*, testicles; *cd*, *cd'*, deferent canals; *c*, prostatic canals; *o*, ovary; *gc*, shell-gland; *cl*, Laurer's duct; *vg*, vitellogenes; *dv*, vitelloducts; *u*, uterus; *pg*, genital pore; *f*, caudal foramen.

DISTOMIASIS OF THE GUINEA-PIG.—Del Chiappa has found, in the biliary ducts of a Guinea-pig, two specimens of a species of Distomum that Sonsino has provisionally named *Distomum caviæ*. Its branched intestine places it in the sub-genus *Cladocœlium*. After being kept a long time in alcohol, one measured 12 mm. long and 9 mm. broad, the other 8 mm. by 6 mm. They resembled the *D. hepaticum*, of which they were perhaps only young specimens.

DISTOMIASIS OF THE CAMEL AND ELEPHANT.—Cobbold states that *D. hepaticum* is found in the Camel, but distomiasis must be rare in that animal. This authority also asserts, in treating of the Fluke, that the Elephant is often seriously infested. 'As causing disease, and zoologically speaking, this entozoon is the most important of the whole group of parasites infesting Elephants.' Not much appears to be known of the parasite. It is described as closely allied to the *D. hepaticum* of the Sheep, but rounder in outline and otherwise differing to an extent as, in the opinion of Cobbold, to warrant its being classed as a distinct species—*Fasciola Jacksoni* Cobb.

It accumulates in the bile-ducts, seriously debilitates the host, profoundly alters the liver—as in the Sheep—and frequently causes death. Much loss among Elephants from Flukes has occurred in our Indian possessions, and especially in Burmah. 'There is every likelihood that the mollusc harbouring the Cercarian larva of *Fasciola Jacksoni* is small, and possessed of amphibious habits.'—Cobbold.

2. Distomiasis in the Carnivora.

On several occasions, the presence of Distomes in the biliary canals of the Dog and Cat has been recorded.

Van Tright classed with *Distomum lanceolatum* those which he discovered in the Dog, and Leuckart cites the Cat among the hosts which harbour that parasite; but it is possible that these cases should be classed as belonging to one of the two following species, which are included in the sub-genus *Dicrocœlium*.

1. **Distomum truncatum** (Rud., *D. Conus* Creplin, *D. conjunctum* Cobb., *D. felineum* Riv., *D. campanulatum* Erc.).—Sonsino has demonstrated that the Distomes of the Dog and Cat, described under these different names, belong to one species—a fluke, the maximum length of which is 7 mm., and breadth 2 mm. Body reddish in the fresh state, depressed, covered—at least, when very young—with very small spines that are easily shed; anterior part conical, and distinct from the rest of the body from the ventral sucker, which is a little smaller than the oral one. Intestine divided into two simple cæca, which are prolonged to the posterior extremity. Genital openings in front of the ventral sucker. Testicles more or less lobulated, situated one behind the other at the posterior part of the body. Ovary lobular, situated on the median line, at the posterior third of the body. Vitellogenes short, occupying the middle third of the body, and formed of seven glomerules on the left, and eight on the right side. Ova operculated, with a small, acute prominence at the pole opposite the operculum; their length is 26 μ to 30 μ, and width from 12 μ to 15 μ.

This Distome was first found in the Greenland Seal (Otto and Rudolphi), then in the Cat (Creplin, Rivolta, Zwaardemaker, Generali), Dog (Ercolani, Rivolta, Zwaardemaker, De Jong, Sonsino), American Fox (Cobbold), Indian Pariah Dogs (Lewis). It is frequent in Holland and in India. It lodges itself in the bile-ducts and gall-bladder, and gives rise to a cirrhosis which has been studied by Zwaardemaker, and which we have also observed in the Cat.

2. **Distomum sinense** (Cobb., *D. spathulatum* Leuckart).—A fluke 10 mm. to 13 mm. long, and 2 mm. to 3 mm. broad, flat, almost transparent in the fresh state, and with a smooth integument. It differs from the preceding species chiefly by the form of its testicles, which are constituted by a small number of slightly ramifying tubes. Ova elliptical, with brown shell, and measuring 28 μ to 30 μ long, and 16 μ to 17 μ broad.

This species is special to China and Japan, and it is also a parasite of the bile-ducts of Man. Ijima has often met with it in the liver of the Cat, and he states that this animal also harbours a smaller species, the skin of which has fine spines; but it appears to be the *D. truncatum*.

CHAPTER V

PARASITES OF THE PANCREAS AND SPLEEN

PANCREAS.—The pancreas is very rarely invaded by parasites; but Echinococci, the agamous *Sclerostomum equinum*, *Ascaris suis*, and *A. Megalocephala* have been found in it, though the health of the animals had not been affected thereby (Florman, Goubaux, Liénaux, Montané).

SPLEEN.—The parasites of the spleen are not common. They are the Linguatulas in the Dog, Cysticerci in the Pig, and Echinococci in animals capable of harbouring them—Ox, Pig, and Sheep. Ostertag has found in the spleen of a Cow an old multilocular Echinococcus, partly calcified, and surrounded by a fibrous capsule. In the spleen of a Horse, Dieckerhoff met with a sterile hydatid the size of a Canary's egg, but there was no other lesion; while, in the spleen of a Cow, Lucet observed a cyst containing an adult living *Distomum hepaticum*. *Œsophagastomum columbianum* has been found under the capsule of the spleen of the Sheep.

BOOK III

PARASITES OF THE SEROUS MEMBRANES

THIS book will only treat of the animal parasites of the peritoneum, pleuræ, and pericardium, which are, however, often of the same species; those of the arachnoid will be dealt with when we consider the diseases of the cerebro-spinal axis; the synovial serous membranes have not yet been recorded as the seat of parasites.

The three larger serous membranes which we have mentioned, closely adjoin each other, and it is therefore advantageous to examine the parasites they may contain, as the majority of them arrive through the abdominal digestive organs, which they first traverse in order to reach their selected location.

These parasites are relatively rare, and come from a small number of species belonging to the Cestodes, Trematodes, and Nematodes.

EQUIDÆ.—Erratic Echinococci may be met with in the pleuræ and peritoneum of the Horse. Liénaux has published a remarkable case of echinococcosis of the pleuræ and lungs of a Horse; nearly the whole surface of the membrane was covered with Echinococci.

Railliet has found in the mesentery of a Horse, some cysts containing the *Sclerostomum equinum* in an agamous state, and Kitt has collected adult Sclerostomes in the peritoneal cavity of two horses.

Cysticercus fistularis Rud.—Rudolphi gave this name to a Cysticercus that Chabert found in the peritoneum of a Horse, and several specimens of which were preserved in the museum of the Alfort Veterinary College, but are not there now. Some years afterwards, a similar parasite was found at the Berlin Veterinary School by Reckleben.

The entire worm is an elongated oval, broader behind than in front, and 7 cm. to 13 cm. long, by 12 mm. to 14 mm. at its widest part. The head is small, tetragonous, suckers little developed, and carries a double crown of hooks. The body, very short, is succeeded by a caudal vesicle, which is slightly enlarged at the posterior part. The mature tænia is unknown.

Filaria equina (Abildgaard, *F. papillosa* Rud.).—Body long, filiform, white, attenuated at both ends, and especially behind. Mouth small, and provided with a chitinous infundibuliform ring, the border of which is divided into four rounded and salient papillæ; outside this ring are other four sub-median papillæ, in the form of spinules. *Male* 6 cm. to 8 cm. long; tail curved in a spiral manner, and having eight papillæ on each side, of which there are four pre-anal and four post-anal; two unequal spicules enveloped in a transparent sheath. *Female* 9 cm. to 15 cm. long; tail slightly spiral, and terminated by a papilla preceded by two others. Vulva situated near the anterior extremity. Ovoviviparous.

This Filaria is frequently met with in the peritoneal cavity, more rarely in that of the pleura of the Horse, the Ass, and Mule, and principally in cachectic animals. Usually only a few are found at a time, and the females are more numerous than the males; but occasionally they occur in large numbers, and Menges asserts that he collected as many in the thoracic cavity of a Horse as would fill a small basket. The lungs were transformed into a vast purulent cavity. This observation is quite exceptional, if it is not erroneous; for the pleural and peritoneal membranes themselves ordinarily appear to be indifferent to the presence of Filariæ.

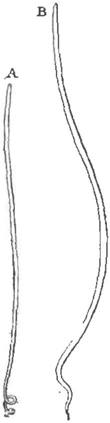

FIG. 285.—*Filaria papillosa* of the Horse; natural size. A, male; B, female.

Macgillivray, of Banff, was castrating a year-old Clydesdale colt, and in opening the right scrotal sac, along with a large quantity of fluid, there escaped thirty-five worms, from 1 inch to 1½ inch long, all very lively; and from the left sac there emerged twenty-one worms of the same kind. They had evidently descended from the abdominal cavity. About a fortnight after castration the colt died of hydrops abdominalis, and in the abdominal cavity were found thousands of these worms crawling about on the surface of the viscera.

This Nematode has been observed also in the arachnoideal space, in the sub-peritoneal connective tissue, and in the substance of the diaphragm. To this species belong the Filariæ found in the interior of the eye. Baruchello has also attributed to it the cutaneous helminthiasis of the Horse already referred to. The course by which the Filariæ of the Horse find their way to their final locality is not known.

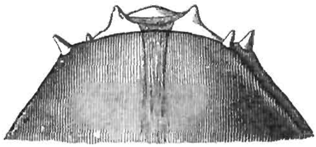

FIG. 286.—Cephalic extremity of the *Filaria papillosa* of the Horse; magnified 150 diameters.

RUMINANTS.—Independently of the Echinococci, there are often found in the peritoneum of various Ruminants—and, in particular, the Ox, Sheep, Goat, Camel, and Reindeer—the Cysticercus of the *Tæniæ marginata* of the Dog—the *Cysticercus tenuicollis* Rud. It is rarely met with in the pleura or pericardium.

The *Cysticercus tenuicollis* has an elliptical caudal vesicle from 15 mm. to 50 mm. long, and is often as large as a Pigeon's egg. The head is similar to that of the *Tænia marginata*, and is invaginated at the bottom of a slit observed at the free extremity of the scolex, which is from 14 mm. to 30 mm. long, and plicated transversely.

Known to butchers by the name of *Water-ball*, this Cysticercus may be found in varying number and size in animals slaughtered in the abbatoirs. It does not appear to cause any disturbance of health—at least, in the majority of cases. Its action is limited to the formation of the cyst that lodges it. Nevertheless, as already stated (p. 422), Baillet in his experiments to establish that the *C. tenuicollis* is the cystic form of *Tænia marginata* of the Dog, produced in Lambs and Kids grave—sometimes fatal—lesions. These experiments show that the ova of this Tænia reach the intestines with the food and water, and that the majority of the embryos attain the peritoneal cavity in passing through the liver. On the tenth day after infestation, in fact, the liver is found traced on its surface and in its substance by sinuous galleries, each occupied by a small blood-clot, and one, two, or three vesicles (or *bladders*) of ·5 mm. to 3·5 mm. in diameter. The head only begins to appear towards the twenty-fifth day; it is well formed about the fortieth day, and in about the seventh to the eighth month the Cysticerci are completely developed. Certain experimental animals succumbed to a diffused hæmorrhagic hepatitis, or to peritonitis. We have also seen that similar occurrences were observed in Pigs under ordinary conditions—by Leuckart and by Boudeaud, and in the Cow by Pütz.

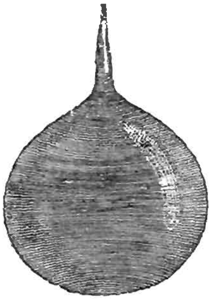

FIG. 287.—*Cysticercus tenuicollis*, with the head evaginated; natural size.—Railliet.

On the other hand, Fromage de Feugré has collected the *Cyst. tenuicollis* in the liver of a Sheep, and we have also met with it in the muscles of this animal (see *Pseudo-Measles in Sheep*). Fleming found this Cysticercus in the subcutaneous connective tissue and the superficial muscles of a Lamb that died from Filariæ in the air-passages.

As the *Cysticercus tenuicollis* very rarely produces serious alterations, we need only say that it would be useful to suppress the original cause—the *Tænia marginata*—by preventing Dogs having access to viscera infested with *Cyst. tenuicollis*.

Morot found a cystic tumour containing *Distomum hepaticum*, on the inner surface of the abdominal wall of a Cow.

Filaria of the Ox (*Filaria cervina* Duj., *F. labiato-papillosa* Alessandrini, *F. terebra* Dies.).—Alessandrini was the first to distinguish this Filaria from that

of the Horse, and Baillet has shown that it belongs to the same species as that of the Deer. It much resembles that of the Horse, from which it differs, however, by the absence of the four posterior—submedian—papillæ around the mouth, by having no integumentary striæ, and by the caudal papillæ of the female which terminate in a fasciculus of small blunt points, preceded by two thick conical lateral papillæ. The length of the male is 5 cm. to 6 cm., and of the female 6 cm. to 10 cm. It is ovoviviparous.

This Filaria is sometimes met with in the peritoneum of Cattle, but no pathological effects have been attributed to it. The Filaria described by some veterinary surgeons as found in the eye of the Ox, is considered as belonging to this species.

PIG.—Beside the Echinococci, the *Cysticercus tenuicollis* and *Stephanurus dentatus* have been found in the peritoneal cavity of this animal.

Cysticercus tenuicollis.—This parasite occupies the same *habitat* in the Pig as it does in Ruminants—that is, the peritoneal folds; but it may also localize itself in the liver, a remarkable instance of this occurrence in the Pig having been given by Semmer. In the Pig, this Cysticercus may also exceptionally follow the example of the *C. Cellulosæ*, in occupying the muscular portion of the diaphragm.

FIG. 288.—Cephalic extremity of the *Filaria cervina*: magnified 150 diameters.

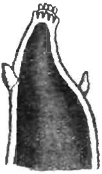

FIG. 289.—Caudal extremity of the female *Filaria cervina*; magnified 150 diameters.

Stephanurus dentatus (Dies.).—This is a Nematode belonging to the family of Strongylidæ, and related to the Sclerostomes (see p. 279), but differing from them by the body being attenuated in front, the presence of a single spicule, and a multilobular pouch in the males. The only species known is the *S. dentatus.*

The mouth is terminal and orbicular, with six very small teeth, of which the two opposed are the strongest. The *male* is 22 mm. to 30 mm. long, the *female* being 30 mm. to 40 mm.

Natterer was the first to find this worm in Brazil, in cysts of the mesentery of a Chinese Pig. White found it in the United States, where it appears to be very common, and Verrill has described it under the name of *Sclerostoma pinguicola.* Cobbold also reported its existence in Australia, and stated that it was met with in the abdominal viscera, especially in the adipose tissue surrounding these organs. No doubt, a more than exaggerated *rôle* has been attributed to it in the development of the diseases which have destroyed so many Pigs in the United States. However, Lutz has observed peritoneal effusion and fistulous induration around the kidneys where it has been met with.

RABBIT.—The *Cysticercus pisiformis* Zeder—the cystic form of the *Tænia serrata* of the Dog—is the most common parasite in the peri-

toneum of the Rabbit. We have already seen the phases through which it passes in traversing the liver, before reaching the peritoneum, where, when it has arrived, it excites the formation of the cyst that envelops it, and appears as a small bladder full of fluid, and about the size of a pea. It is sometimes found in such numbers as to resemble clusters of grapes. On the surface of each bladder is noticed a white spot; this is the scolex invaginated in the interior of the vesicle, from which it is easy to evaginate it. The head has all the characters of that of *T. serrata*.

There ought to be classed with this species, the *Cyst. elongatus*, described and figured under this name by Leuckart. Its distinctive feature is the great length of its vesicle. It is usually encysted in the pelvic peritoneum. But whatever Leuckart may say, it does not appear to be different, in the number and character of its hooks, from *Cyst. pisiformis*.

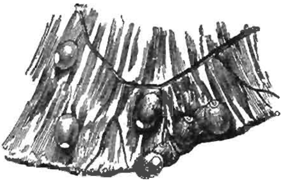

FIG. 290.—Fragment of the mesentery of a Rabbit invaded by the *Cysticercus pisiformis*; natural size.—Railliet.

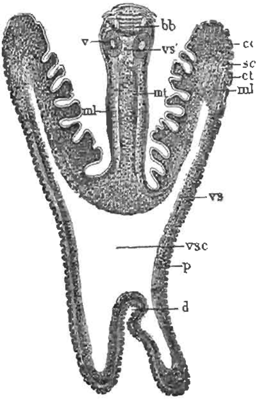

FIG. 291.—Section of the completely developed *Cysticercus pisiformis*; magnified 15 diameters. The head is invaginated, and is succeeded by a long portion that passes nearly entire in the adult state.—Moniez.*

* *d*, a constant depression at the posterior part of the Cysticercus, due to atrophy of a portion of the body at the preceding stage (represented in Fig. 261); *vs*, section of vessels in the vesicle or bladder; *vs'*, section of the vessels where they anastomose; *vsc*, vesicle; *p*, papillæ; *ct*, cuticle; *sc*, subcuticular layer; *cc*, calcareous corpuscles; *ml*, longitudinal muscular fibres; *mt*, transverse muscular fibres; *v*, suckers; *bb*, cephalic bulb.

It is also probable that—as Diesing remarks—the parasite found by Kuhn in the peritoneum of the Rabbit, and named by him *Monostoma leporis*, is the *Cysticercus pisiformis*.

'There are sometimes found—and especially in wild Rabbits—*Cysticerci pisiformes* which have left their cysts, and are sometimes even evaginated and have begun to develop their segments. Mégnin has imagined that these worms, in passing into the intestine, are transformed into *T. pectinata*; but there is no proof in support of this, and our personal experience does not agree with these indications' (Railliet).

DOG AND CAT.—The large serous cavities of the Dog and Cat rarely lodge parasites. Up to the present day there have been found only Cestodes in the larval form—the *Dithyridium elongatum* and Echinococci, the giant Eustrongylus, the *Linguatula*, and an undetermined Pentastome.

Dithyridium elongatum, Blumberg (*Plerocercoïdes—Cysticercus—Bailleti*).—Body very extensible and contractile, and narrow; it may measure 105 mm. long, but usually does not exceed 1 cm. to 2 cm. The anterior part—which is 1·5 mm. to 3 mm.—is of an opaque white, irregularly plicated, and shows at its summit a longitudinal slit—the invagination opening. The head—very difficult to evaginate—is irregularly globular, and has neither rostellum nor hooks, but is provided with four elliptical and usually dark-coloured suckers, measuring ·5 mm. to ·6 mm. in diameter. The anterior portion is succeeded by a narrower distended part in the form of a tail scarcely attenuated behind, where it is about 1 mm. broad. In small specimens this tail is very short, and they are cordiform because of the anterior slit. The whole body is full of calcareous corpuscles. This Cystic form maintains its movements for a long

FIG. 292. — *Dith. elongatum* (*Cysticercus Bailleti*); natural size.

FIG. 293.—Evaginated head of the *Dith. elongatum* (*Cysticercus Bailleti*); magnified 50 diameters.

time in tepid water—even when the autopsy has been made forty-eight hours after the death of its host, it will be found moving.

Railliet has named this bladder worm, which had been unnamed, *Cysticercus Bailleti*, as Baillet was the first to find it in the Cat and Dog. It appears to us to belong to the Plerocercoïdes of Braun, which includes the larval form of Bothriocephalus. Several of the *Piestocystis* of Diesing—and particularly *P. martis* and *P. laxi*—are probably only examples of the Plerocercoïdes.

Baillet has met with these parasites in two cats: in one Case 21 were found in the peritoneal cavity, and in the other 80 were discovered in the pleural sacs. He also found 12 young specimens in the peritoneum of a Rat. Blumberg described them anew, and figured them; he met with a small number in the pleura of one Cat, a considerable quantity in the peritoneum of another, and about 100 in the pleuræ and peritoneum of a Dog. Our colleague, Labat, has had occasion to observe these parasites in a Dog affected with Ascites; the fluid extracted by paracentesis contained a certain number of great size, and at the autopsy a considerable quantity

were found encysted in the peritoneum, the large omentum, and the lungs. In 19 of 76 Cats, we have found them in the pleuræ or peritoneum, or in both together; in 14 the numbers were one, two or three; once there were six, once twelve, and in three others they were in very large number in the pleuræ and peritoneum. In two of the cases in which they were numerous, many of them—not yet having grown larger, than a millet-seed—were lodged in the texture of the great omentum, in the interior of cysts varying in colour from yellow to brick-red. These cysts contained from one to seven, and they were nearly all situated on the course of the omental vessels. It might therefore be supposed that, before being set free in the serous cavity, these parasites are at first encysted in the substance of the membrane, and that they are probably brought there from the stomach or intestine by the blood-circulation. At Toulouse the Dithyridium has been found in 25 per cent. of the Cats examined.

We have found 5 young Plerocercoïdes in the peritoneal cavity of an Ichneumon (*Herpestes Ichneumon*), 4 in the same cavity of a Pole-cat; and a great number in the peritoneal and pleural cavities, as well as beneath the visceral serous membrane of the liver and lungs, of a Fox.

Echinococci.—Six instances are known of Echinococci in the peritoneal cavity of Dogs, and in all the infested animals were considered dropsical.

The first is due to J. Hartmann, who, in 1694, found in the peritoneum of a Dog such a large number of hydatids, as to fill several plates with them. Their volume varied from that of a pea to a hen's egg; some were free, others adhered to the peritoneum and to all the organs it covered; the liver alone was penetrated by them, but these were generally of small size. Although Hartmann mistook the nature of these hydatids, yet this cannot be doubtful when the two following instances are considered.

The second published observation belongs to Reimann. The majority of the Echinococci varied in size, from that of a hazel-nut to a small hen's egg; the smallest was as big as a pea, the largest as voluminous as a man's fist. They belonged to simple types—endogenous and exogenous—the latter predominating. The scolices were abundant; but there were, nevertheless, many acephalocysts. The hydatids were spread over the whole of the peritoneal cavity, even into the pelvic cavity and the vaginal sac around the testicles; but there were none on the parietal or visceral serous membrane, nor yet in the interior of the abdominal organs. Those which were not free adhered to the mesentery or omentum. Their quantity was considerable, and they weighed about 8,872 grammes, of which 6,672 were made up of free Echinococci from the peritoneal cavity, and these were six litres by measure. The total number was estimated at 3,000. The parietal serous membrane was inflamed in places.

The other cases occurred in our own experience. In the first, which may serve as a type, with the exception of three vesicles, the size of a nut, all had a volume varying from that of a pin's head to that of a pea; in this respect they approached the type of the multilocular Echinococcus. Our persevering search could not enable us to discover a single head, and it is known that they are somewhat rare in the multilocular Echinococci. Nearly all the hydatids belonged to the exogenous type; and they measured, with the clear fluid in which they were suspended, between 4 and 5 litres. It was not possible to count them, but there were certainly more than 100,000. Besides filling

the peritoneal cavity, they adhered here and there on different parts of its surface; and they were also found in the middle lobe of the liver—which was full of them—and in the omental fissure of the spleen. There was general chronic peritonitis.

These observations are remarkable for the enormous quantity of hydatids found in each; and in this respect they have some analogy with that of Anel, having reference to a dropsical Man. The small size of the vesicles, their great number, and the absence of scolices, class them with the multilocular Echinococci.

With regard to the origin of these Echinococci of the Dog, this is inexplicable. In the two last observations—and probably in the first—the Dogs did not harbour the *Tænia echinococcus* in their intestine; but as they might have been bearers of it previously, there is reason to ask if exceptional auto-infestation had not taken place by one or more Tæniæ, the embryos of which could pass spontaneously through the intestinal wall, or be favoured by some primary lesion; for in the spleen of our Dog there was found a sewing needle, that had probably come from the intestine. In order to verify this hypothesis, we have on several occasions introduced living and mature *Tænia echinococcus* into the peritoneal cavity of a number of Dogs, but with negative results. This might have been anticipated, as the ova had not previously undergone the erosive action of the gastric juice, which is necessary in order to set the embryos free.

Linguatula.—In each of two Cats, we have met with a free larval form of *Linguatula denticulatum* in the peritoneal cavity.

Pentastoma.—Bochefontaine has found in an experimental Dog, in apparent good condition, thousands of free agamous Pentastomes in the peritoneal cavity, or lodged in cysts on the hepatic peritoneum, or in the mesentery; each cyst containing only one parasite. These larvæ were 16 mm. long and 2 mm. to 3 mm. broad; they were white, cylindrical, moniliform, the extremities being rounded, about equal, but a little attenuated behind. Mégnin considered them—but without sufficient cause—as belonging to the *Pentastoma moniliforme* Dies., which, in the adult state, is only found in the lung of the striped Python.

Birds.—Baillet found in the peritoneal cavity of a Fowl, three Cysticerci the size of a millet-seed, each of them being isolated in a cyst. The head had four suckers, but no proboscis or hooks.

The *Filaria cygni* Rud., found by Redi, has already been studied in dealing with the intestinal worms of the Swan.

BOOK IV

PARASITES OF THE RESPIRATORY APPARATUS

PARASITISM of the respiratory organs is very frequent. Their wide, constant, and necessary communication with the atmosphere, permits the innumerable germs floating about in it to penetrate to their inmost recesses. Parasites, in the larval condition and of very small dimensions, may also find their way into them during the prehension of food and drinking of water—agents which afford these minute creatures shelter, or serve as transitory vehicles. They enter by the nostrils or the mouth, untilizing the communication of the latter cavity with the vestibule of the air-passages.

Parasites may also arrive at the lungs by travelling from the stomach or intestines, which at certain points they can only do by boring through the walls of these, and passing through the diaphragm and the serous membranes covering it. Perhaps they may also reach the respiratory organs in being carried passively by the blood, in those vessels which they meet with during their active migrations. The air in the breathing apparatus constitutes one of the conditions that determine the *habitat* of several of these parasites.

In consequence of their great sensitiveness, the respiratory organs are not very indifferent to the presence of parasites, which usually betray their existence in them by well-marked symptoms, which are furnished by the semeiology proper to these organs. The disturbances that ensue in the respiration are sometimes so serious as to jeopardize the health of the host; but they otherwise vary according to whether the parasites are lodged at the commencement or in the depths of this apparatus.

A.—DOMESTICATED MAMMALIA

CHAPTER I

PARASITES OF THE NASAL CAVITIES AND LARYNX

We have already seen (p. 281) that the *Hæmopis*, which prefers the hard and soft palate and pharynx of the Horse, may also be found in the nasal cavities and entrance to the larynx. We have also noted that when the larvæ of the Gastrophilus become fixed on the margin of the epiglottis, or the vicinity of the larynx, of the Horse, they occasion very frequent fits of coughing that may terminate in asphyxia.

Beyond the more or less exceptional instances, the special parasites of the nasal cavities are *Coccidia* in the Rabbit, *Linguatula* in the Dog, and the *larvæ* of the *Œstridæ* in the Sheep, Camel, and Deer.

Article I.—Nasal Coccidiosis of the Rabbit.

This affection, described by Zürn under the names of *Rhinitis* or *Psorospermic Catarrh*, and *Malignant Catarrhal Fever of Rabbits*, appears to be common in Germany. It is due to invasion of the mucous membrane of the nose, pharynx, and middle ear by coccidia, which probably are identical with *Coccidium cuniculi* (Rivolta).

The symptoms comprise dulness, loss of appetite, unthrifty coat, profuse nasal discharge, aud excessive salivation—the saliva wetting the muzzle, lips, breast, and fore legs. Frequent sneezing and fits of coughing; increasing fever, laboured respiration, and aggravation of all the symptoms. Death takes place in convulsions.

The nasal catarrh may be complicated by sore throat, with difficulty in mastication and deglutition, and by laryngeal rattling, which is most marked during feeding. Sometimes there is a purulent conjunctivitis, with non-encysted coccidia in the discharge. When the middle ear is attacked the animal inclines the head—at first only when eating, then permanently—to a degree

that sometimes one eye looks upwards and the other towards the ground.

This disease is usually accompanied by intestinal coccidiosis, and its progress is very rapid. The principal lesions are intense inflammation of the mucous membrane of the nose and pharynx; the nasal cavities contain a reddish-yellow fluid composed of mucus and blood serum mixed with coccidia and pus cells.

When the ear is affected, the lining of the middle ear, Eustachian tube, and external auditory canal is inflamed. Purulent mucus fills the cavity of the tympanum, and the *membrana tympani* may be perforated. Coccidia are found under the epithelium and within the epithelial cells. The inflammatory process sometimes extends to the labyrinth, and the vessels of the cerebral dura mater may be much injected.

The treatment is the same as that already indicated for Hepatic Coccidiosis.

ARTICLE II.—**Linguatulida.**

The **Linguatules** are the most interesting species of the order *Linguatulida*, which is thus characterized:

Endoparasitic Arachnida, with an elongated, vermiform, and annulated body. Mouth destitute of jaws in the adult, and surrounded by two pairs of hooks representing rudimentary legs. No heart. Respiration cutaneous.

This order only comprises the two genera, PENTASTOMA and LINGUATULA, separated by Railliet, and already indicated by Leuckart as sub-genera. Their characters are as follows:

Pentastoma (Rud.).—Body cylindroid, with continuous cavity. This genus has no representative in the domesticated animals, unless it be a larval form once found in the peritoneum of a Dog.

Linguatula (Frölich).—Body depressed, dorsal surface rounded, borders crenellated, the cavity of the body forming diverticuli in the lateral parts of the rings or segments.

The species which the domesticated animals harbour is very often named, in the adult state, *Linguatula tænioides*.

Linguatula tænioides (*Linguatula rhinaria* Pilger, *Pentastoma tænioides* Rud.).—Body white, lanceolated, very elongated, vermiform, flattened from above to below, the ventral surface nearly plane, the dorsal surface rounded; anterior extremity broad and rounded; posterior extremity attenuated. Cephalothorax short, and joined throughout its breadth to the abdomen, which is scarcely distinct, and which forms by far the greater part of the body. Integuments show about ninety rings or segments, widest in their middle, which causes the margins of the body to be distinctly crenulated. Hooks sharp, curved, bi-articulated, the basilar article attenuated in its deeper portion. These hooks are each retractile in a small sheath or fossette, and are moved by muscular cords arranged in different directions. Mouth subquadrangular, and rounded at the angles; digestive tube simple and rectilinear; anus terminal. *Male* white, 18 mm. to 20 mm. long, 3 mm. broad in front, ·5 behind, and provided with two sacciform testicles, which occupy the posterior three-fourths of the cavity of the body. *Female* greyish-white, often rendered brown by the ova placed along the middle line, where the

integument is thin and semi-transparent ; from 8 cm. to 10 cm. long, 8 mm. to 10 mm. broad in front, and 2 mm. behind. Eggs ovoïd, 90 μ long and 70 μ broad.

The nervous system is composed of a non-œsophageal ganglion, the two lobes of which are united by a commissure passing above the œsophagus, and completing the œsophageal ring. It gives off three or four filaments that go to the cephalo-thoracic organs, and two long cords parallel to the intestine. There are no sensory organs, though Leuckart has described, as tactile organs, scarcely visible appendages situated at the anterior border of the cephalo-thorax. Organs of circulation and respiration are also absent.

FIG. 294.—Female *Linguatula tænioides* ; natural size.

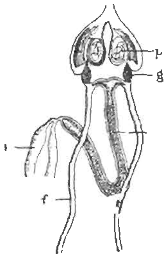

FIG. 295.—Genital apparatus of the male *Linguatula tænioides*.—Leuckart.

t, testicles ; *vs*, seminal vesicle ; *g*, glandular portion of the deferent canals ; *f*, flagellum ; *p*, penis coiled up.

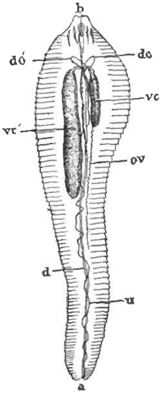

FIG. 296.—Anatomy of the female *Linguatula tænioides*.—Leuckart.

b, mouth ; *d*, digestive canal ; *a*, anus ; *ov*, ovary ; *do*, *do'*, oviducts ; *vc*, *vc'*, copulatory pouches ; *u*, vagina or uterus.

Evolution.—The female *Linguatula tænioides* deposits its ova in the nasal cavities of the Dog which is its bearer. These ova are expelled along with mucus during the fits of sneezing induced by the presence of the parasite. Those which fall on the grass of pastures or on forage are retained there, surrounded by mucus, and may in this state resist atmospheric influences for several weeks. If this soiled grass or forage be eaten by any herbivorous animal—

Sheep, Rabbit, Ox, etc.—the shell of the eggs is dissolved, and the embryos, which had begun to appear immediately after the eggs were laid, are set at liberty in the intestine of the new host.

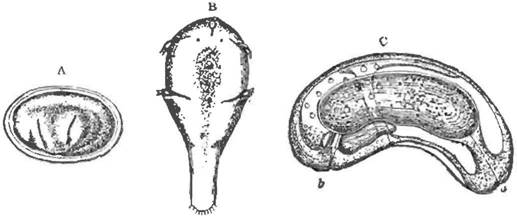

FIG. 297.—First phases of the evolution of the *Linguatula tænioides.*—Leuckart.

A, egg magnified 200 times, and containing an embryo ; B, acariform, tetrapod, free embryo ; C, nympha or pupa 9 weeks old ; *a*, anus ; *b*, mouth.

This embryo has a certain resemblance to the Acarina (Fig. 297, B). It is ovoïd, flat on the ventral surface, round on the dorsal surface, and constricted and dentated at its posterior extremity. It measures 130 μ long, and 60 μ broad ; it is furnished with two pairs of articulated, bi-ungulated legs, and at its anterior part it has a perforating apparatus formed by a median stylet and two curved hooks. By means of this apparatus it bores through the wall of the digestive tube, and reaches the organ in which it is to be encysted—mesenteric glands, liver, lungs, etc.

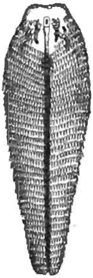

FIG. 298.—*Linguatula denticulatum,* larva of the *Linguatula tænioides* ; magnified 10 diameters.—Railliet.

Arrived at this first destination, it loses its rostrum and legs, and is transformed into a motionless, rolled-up pupa, showing no trace of segments, hooks, or bristles, and measuring 250 μ to 300 μ long, by 180 μ broad (Fig. 297, C). At the end of eight weeks after infestation, Leuckart observed these encysted nymphæ.

Some time afterwards they are transformed into secondary larvæ by a series of successive moultings (Fig. 298). The body is elongated, broader in front, and divided into 80 to 90 segments, which have a series of fine points on their posterior border. The digestive canal is very wide ; the mouth is elliptical, and encircled by four characteristic hooks, as well as accessory ones. This larva is agamous, for its genital organs are only represented by a small

granular mass situated in the posterior part of the body. Towards the sixth or seventh month, the larva is completely developed, measures 6 mm. to 8 mm., and represents that which has been designated the **Linguatula denticulatum.**

After a certain time, these mature larvæ begin to move by means of their hooks and the chitinous spicules on their skin, which prevent slipping back. They leave their primary location, fall into the peritoneal or pleural cavity, and the majority of them die. There are some, however, which succeed in encysting themselves on some other point, and Colin has found traces of these internal migrations. It is not impossible—as Gerlach imagined—that they sometimes reach the bronchi, thence to be thrown out of the body of the host; and then they would be capable of resisting desiccation for a long time, and returning to active life under the influence of humidity. It might also be admitted—according to the same

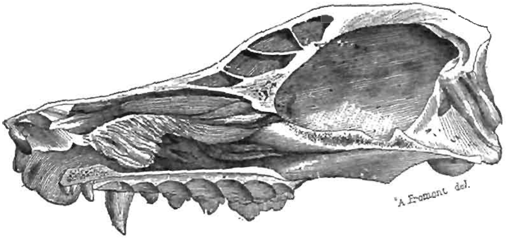

FIG. 299.—Head of a Dog opened in the middle, showing three of the *Linguatula tænioides* (two of which are placed side by side) in the nasal cavities.—Colin.

authority—that they could, after having attained the bronchi, reach the nasal cavities of their host, and there become perfect. In this way would be explained the presence—quite exceptional, it is true—of the *Linguatula tænioides* in the nasal cavities of the herbivora; and the presence of free larvæ found by Gurlt in the trachea of a Hare and a Goat support this hypothesis.

One thing is certain, that in general, these larvæ cannot acquire their complete development except in the respiratory apparatus. They only survive a few days after they leave their original host unless the viscera of this is devoured by a carnivorous animal, a Dog, for example. Then these agamous Linguatules reach the nasal cavities of their new host, either by the nostrils, the guttural openings, or in ascending from the œsophagus or pharynx. Gerlach admits also that they may arrive in the trachea, after passing through the wall of the stomach, and the peritoneum, pleura, and lungs. Once installed in the nasal cavities, toward the third week

in one moulting they lose their numerous spicules—which have now become useless—and wear a simple smooth skin. At the same time, the genital organs complete their development—those of the male sooner than those of the female. They may copulate about the end of the sixth or seventh week.

The area they occupy is somewhat limited. The males are nomadic, and will be found at different points in the nasal cavities—even in the pharynx and larynx, no doubt in search of the non-fecundated females; but most frequently they are hidden away in corners. The females are more sedentary, but—contrary to the assertion of Chabert—they are never found in the ethmoidal cells, and it is only after the death of their hosts that they wander into the pharnyx, and even into the larynx. Gellé found one in the middle ear of a Dog, where it had penetrated by the Eustachian tube. Exceptionally they pass into the frontal sinus, in which they are sometimes found half engaged. But in general they are only met with at the bottom of the meatuses, between the turbinated bones, and in the interstices between the ethmoidal volutes—their favourite abode being the wide and regular hollow that constitutes the *cul-de-sac* of the middle meatus. There they are sheltered from the respiratory currents of air, while the secretion of the mucous membrane—rich in glands—provides them with an abundant alimentation.

But little developed at the time of coupling, the females soon after this event assume their definite size, chiefly owing to the accumulation of eggs in their oviduct. The number of these is considerable, Leuckart estimating them at 500,000 in one female. Ovulation begins towards the sixth month of the parasite's nasal existence, and is continued for an undetermined period.

Concisely stated, the evolution of the Linguatula may be said to comprise four distinct and successive stages: 1. Acariform embryo; 2. Encysted nympha; 3. Free or encysted larva—*Linguatula denticulatum*; 4. Adult state in the nasal cavities—*Linguatula tænioides*.

Frequency.—The majority of authorities consider the *Linguatula tænioides* as a rare parasite in the nasal cavities of the Dog; but Colin, on the contrary, has asserted that it is very common, at least in Central France; in 630 Dogs which he had opened within two years at Alfort, at all seasons, 64 of them had from 1 to 11—in all, 146 parasites—a proportion of about 10 per cent. But it would not appear to be the same at Toulouse, for in 60 Dogs examined with this special object, only 5 furnished Linguatules, the number of which varied from 1 to 4.

A knowledge of the migrations of these parasites allows us to understand their extreme rarity in house Dogs, and their relative frequency in shepherds' or butchers' Dogs, as well as in street Dogs.

Action of the Adult Parasite.—The *Linguatula tænioides* has been met with in the nasal cavities of the Horse, Mule, Sheep, Goat,

and even of Man. But its natural host being the Dog, it is chiefly in this animal that the *symptoms* due to its presence are known, and these chiefly through experimentation.

Chabert had manifestly exaggerated these symptoms, and this appears to have been suspected by his contemporaries. Colin has been able to note them from day to day, and so to settle the question.

In wandering into the nasal cavities, the hooks of the parasites produce a slight irritation of the pituitary membrane, and hence some slight sneezings which would not usually attract attention. After some time, when the parasites have become more developed, they hinder the passage of air into the nasal cavities. Then the sneezing is more frequent, sudden, irregular, and sometimes long continued—especially when the respiration has been accelerated by running. Occasionally the animals stop anxiously, take very deep respirations, open the mouth, and attempt to swallow. These periods of agitation are alternated with others of perfect calm. Sleep is often disturbed by difficult inspirations and attacks of sneezing; some animals appear to be even threatened with asphyxia, and in their agony raise their paws to the nose, as if to remove some obstacle to their breathing. They become irritable, but rarely to such a degree as to lead to the belief that they are suffering from epilepsy or rabies.

We have mentioned that, during these fits of sneezing, the Dog ejects mucus charged with ova; it may also throw out the parasites, as has often been noticed.

It is doubtful if the epistaxis remarked in affected Dogs should be attributed to the presence of these parasites; for in the majority of cases the animals are also suffering from intestinal anchylostomiasis, or essential anæmia.

The Linguatules may, in becoming displaced in the respiratory apparatus, cause fatal asphyxia; although those that are found in the larynx are generally introduced there after death (Colin). 'Professor Dick relates an interesting fact with regard to this. It was the case of a Dog in perfect health, which died suddenly, and at the autopsy there was found nothing that could account for death, except three Linguatules lodged—one in the larynx, another in the trachea, and a third in the left bronchus. Cobbold explains this displacement, by observing that the animal had gone out in the morning—it being winter—and that probably the action of the cold air had caused the parasites to wander in search of warmth; hence resulted the asphyxia' (Railliet).

The duration of sojourn of these parasites in the nasal cavities may be very long. Colin has known it to exceed fifteen months. Eventually, however, they are expelled or perish *sur place*, and with them disappear the symptoms.

According to Colin, the lesions are in reality insignificant. The pituitary membrane retains its normal characters 'so completely that, without the aid of the hand-lens, the practised eye would have

great difficulty in discovering the slight imprints of their microscopical hooks.' Leuckart has noted a little injection and softening of the mucous membrane. When, exceptionally, the parasites have located themselves in the frontal sinuses, the mucous membrane is slightly inflamed, and there is a small collection of muco-pus.

The *preventive treatment* consists in keeping Dogs away from the entrails of Sheep, Rabbits, etc., which may contain agamous Linguatules; though the slight gravity of this nasal parasitism would scarcely justify this measure if it did not, at least, have its utility with regard to other parasitic affections—such as those due to the bladder-worms and Tæniæ.

There is no need to have recourse, in *curative treatment*, to trephining of the frontal sinuses, as advised by Chabert, as these cavities are not the usual *habitat* of the parasites. Injections are more indicated, and for these dilute ammonia or benzine, or, better, empyreumatic oil mixed with an infusion of savory—1 oz. of the first in 12 oz. of the second (Chabert)—may be employed. These irritating injections should be followed by emollient fumigations. Inhalations of ammonia or chloroform might be tried (as might also tobacco-smoke, or the fumes of chlorine or burning sulphur). The insufflation of errhine powders, and especially snuff, does not give favourable results.

Action of the Larval Linguatula.—The agamous or denticulated Linguatula is sometimes found encysted and sometimes in the free state, in the abdominal or thoracic viscera of a large number of animals, and it is frequent in the *Sheep*. The mesenteric glands which are commencing to be filled with Linguatules, at first do not show in their appearance anything that might cause suspicion of the presence of these parasites. But soon they become brown in places, are diminished in consistence, seem shrivelled up, and are hollowed out by little cavities full of larvæ. These cavities are at first separate from each other, but often end in communicating as they enlarge, the substance of the gland being destroyed and transformed into a brown fluid, in which the Linguatules swim about. Sometimes there are observed certain glands, on the surface of which are openings with regular borders, by which the parasites have made their escape, to wander elsewhere. At other times the surface of these glands has irregular greenish spots, fibrinous deposits and false membranes, which appear to indicate a recent departure or the destruction of the parasites. The glands which are altered in these several ways are scarcely permeable to the chyle, and nutrition must therefore be unfavourably influenced.

We do not know how long the parasites remain in the glands. We have seen that they die in their *habitat* or emigrate, wander through the peritoneal cavity, and gain the liver or lungs; traces of their wanderings can be found in the various organs.

Ox.—Babes has noticed that the *Linguatula denticulatum* is very frequent in Roumanian Oxen, especially those in the region of the Danube. Of 35 Oxen killed in different localities, not one was free from the parasites.

They were first found in the mesenteric glands, which showed alterations similar to those that occur in Sheep. The parasites left the glands, and crawled on the external surface of the peritoneum, where they were often found between the folds of the mesentery. They reached the intestine in passing through its wall, in which they were often noticed in process of penetration, or hæmorrhagic spots or cicatricial traces marked their emigration.

HORSE.—Csokor has found a *Linguatula denticulatum* in the liver of a Horse.

CAT.—In 76 Cats we have examined, we only found 5 infested with the *Linguatula denticulatum*: a Cat had one in the pleural cavity, another had one in the peritoneal cavity, and the others had 1 to 5 on the surface of the lungs; they were isolated, and coiled up in small subpleural abscesses.

DOG.—In treating of the parasites of the serous membranes, we mentioned the larval Linguatules found by Bochefontaine in the peritoneal cavity of a Dog.

ARTICLE III.—Larvæ of the Œstrus.

The larvæ which live in the sinuses of the head of the Sheep belong to several species of the genus *Œstrus* (Linn.), as it has been established by Schiner.

This genus, in Brauer's classification, enters into the group that has wings with a transverse terminal nervule; the latter is somewhat oblique with regard to the posterior border of the wing, the first cell of which is closed and lengthily pedicellated. The species of this genus are generally of small size, with short and feeble legs, and short and scanty hairs of a silvery tint. Examined at their third stage, the larvæ have a single pair of jaws, two small membranous antennæ, each carrying two oculiform points; the stigmatic plates of the last segment are irregularly pentagonal.

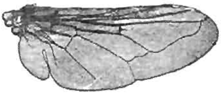

FIG. 300.—Wing of the *Œstrus ovis*; magnified 5 diameters.—Railliet.

FIG. 301. — *Œstrus* of the Sheep; natural size.

Brauer describes four species of Œstrus, only one of which—the *Œstrus ovis*—manifestly lives in the larval state in the sinuses of the Sheep, and probably also the Goat (Railliet).

Œstrus ovis (Linn., *Cephalomyia ovis* Latreille). A small species, of a yellowish-grey hue, and slightly hairy. Face yellow; buccal pieces testaceous. Upper surface of the thorax of a brownish-grey, granular, and streaked by obscure or nebulous lines. Abdomen marbled and spotted with white, yellow, and black, covered with fine hairs behind, having a silky hue. Wings hyaline and transparent, marked at their base by three black points. Length of the body 10 mm. to 12 mm.

This species is very widespread, being found throughout Europe, in Asia, Africa, and the Canary Islands, as well as in the two Americas.

Like the other Œstridæ, it lives in the perfect state during the warm season—from the middle of May to the month of October—and it only flies in dry and warm weather. It hides in holes and

crevices in the walls of the sheepfolds, which it leaves when coupling time has arrived and the temperature is sufficiently high. It then flies in a lively manner to greater elevations, and rests on rocks warmed by the sun. The fecundated female now goes in search of flocks of Sheep, which are afraid of its approach, and to avoid it lie down, bury their nose in the dust between their fore-feet, or are huddled together with their heads down. According to Bracy-Clark, they raise clouds of dust to deceive their enemy. It is during rumination that the insect finds a particularly favourable time for depositing its progeny. Its small size, grey colour, and the rapidity of its flight, do not allow its ovulation to be observed; but there can be no doubt that it does take place on the nose of the Sheep. As soon, in fact, as these animals have been touched by the Œstrus, they become excited, run in every direction, hold down their nose and rub it against the ground or against their feet, often look anxiously around them, sneeze and snort, and seek ditches, furrows, and dusty roads. Owing to the repeated rubbings, the nostrils are often abraded and inflamed.

Evolution.—The non-fecundated ova are reniform. With Dufour and Cockerill, Brauer is inclined to admit that they are hatched in the body of the female. However this may be, the larvæ enter the nasal cavities of the Sheep, crawl into the maxillary and frontal sinuses, even into those of the horn-cores, and are developed.

In the first stage—which appears to be the longest—they are white, transparent, measure as much as 2 mm. long, and greatly resemble those of the *Gastrophilus* of the Horse. During the second stage they are about 6 mm. long, are yellowish-white in colour, have no spines, except a few around the mouth and on the ventral surface of the last segment; the stigmatic plates differ little from those of the adult larvæ.

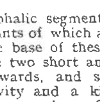

FIG. 302.—Ova of the Sheep Œstrus; highly magnified.

The latter, during the third stage, are a little broader behind than in front. Their ventral surface is plane; the dorsal surface is convex, and on each side has two series of prominences placed one above the other, and separated by a zigzag line. The middle part is smooth, and shows—from the second to the tenth segment—a nude and fusiform ring. At its inferior surface each segment from the third has on its anterior border several series of red-pointed spiniform tubercles. The cephalic segment is furnished with two dark-brown mandibular hooks, the points of which are curved downwards, outwards, and backwards. Between the base of these hooks is the buccal depression, small and nude. Above are two short and thick antennæ. The last segment is sharply truncated upwards, and shows a circular margin projecting above the stigmatic cavity and a kind of inferior lip, garnished with small spines between two mamelons. The stigmatic plates are pentagonal, with rounded angles, and the orifice of the stigmates is towards the centre. When they have attained their maturity, the larvæ are at first white, and have dark, transverse streaks on their segments; their total length is then from 20 mm. to 30 mm. long, and 7 mm. to 10 mm. broad.

The larva remains about ten months in the nasal cavities of the Sheep. Having attained its complete maturity, it detaches itself from the mucous membrane, creeps about, and owing to the large opening between the sinuses and the middle meatus, it leaves its

abode, passes into the nose, and is expelled therefrom by the violent snorting it excites in its host. Twenty-four hours after its exit it is transformed into a nympha; and the shell, which was at first soft and red, with transverse streaks, is now brown, then black, its upper surface being convex, and the lower concave. The duration of nymphosis is from a month to six weeks, and the issue of the perfect insect occurs according to the mode common to the Œstridæ.

FIG. 305.—Opened pupa of the Sheep Œstrus; magnified 3 diameters.

Symptoms.—It is usual to find three or four larvæ of the Œstrus in the frontal sinuses of Sheep, which, during life, had not given any indication of their presence. They rarely occasion any morbid disturbance, unless they are numerous and advanced in development, at the commencement of spring. The first sign of their presence is a discharge from the nostrils, often unilateral, at first clear and serous, then thick and mucoid. Then there are frequent sneezings and snortings, accompanied by the expulsion of mucus, and sometimes of the larvæ. Later, the animals throw the head backwards, often shake it, rub the nose on the ground, against some part of their body within reach, or with the fore-feet. As the malady progresses the Sheep hold their head low, lift their limbs high in movement, as if walking in water—their gait resembling that of horses affected with *immobilité*. Sometimes they suddenly throw up the head, carry the nose high, then move it convulsively. From time to time they stagger and are attacked with vertigo, but they do not turn in a circle. In more serious cases there is dyspnœa, the upper air-passages being obstructed by the larvæ or the inflammation of the pituitary membrane. Their eyes are red and lachrymose. The disease may be more complicated, the animals losing their appetite and their condition; they grind their teeth; foamy saliva flows from the mouth; the eyes pirouette in the orbits; and convulsions set in, then death ensues, sometimes in six to eight days after the appearance of the first symptoms. Randall, describing the disease as he saw it in the United States of America, states that the term 'grub in the head' covers many fatal cases in the spring of the year, but bad effects from it are rare. The symptoms he mentions are: loss of condition, without any assignable cause, in the early spring, bloody mucus from the nostrils, irregular movements, and twisting the head occasionally, as if in pain. Observers in Great Britain have noted severe distress when the larvæ are numerous, and enumerate, among the other symptoms, occasional cough of a suffocative character, frequent sneezing, impeded respiration, swelling around the anterior nares, effusion into the submaxillary connective tissue, great depression—leading in some instances to semi-coma—loathing of food, and diarrhœa, sometimes terminating fatally.

But it is rare that the malady reaches this paroxysm ; it continues for a long time, and generally—the larvæ being ejected one after another—the symptoms gradually subside, until they disappear altogether.

This affection has been sometimes mistaken for 'gid,' caused by the *Cœnurus cerebralis*—whence the names of *false gid* and *Œstral vertigo* which have been given to it. But such a mistake would be avoided by remembering that the Sheep does not move in a circle in this affection, which is nearly always accompanied by nasal discharge and snorting, symptoms which are absent in 'gid'; besides, the latter is generally seen in young animals.

Lesions.—At the autopsy, there are found in the sinuses the still living larvæ of the Œstrus, the number of which is very variable. There are usually from two to about six in one fourth of the Sheep killed from April to July—at least, this is so in the South of France; but frequently there are from ten to fifteen. Greve found great quantities of larvæ in the Sheep that graze on the heaths of Luneburg, Hanover; but they did not appear to give rise to any manifest symptoms, except an intense nasal catarrh (Röll). Hertwig mentions having counted forty in one animal, and Zürn says he has found from sixty to eighty.

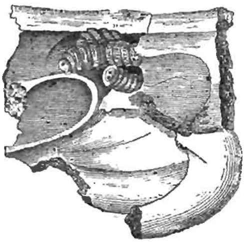

FIG. 304.—Larvæ of the Œstrus in the frontal sinuses of the Sheep. —Joly.

In those animals which have manifested symptoms of parasitism in the sinuses, the larvæ are found enveloped in mucus and pus, which is often fœtid; they occupy the frontal sinus and dependencies, the horn-cores. According to Hertwig, they may also be met with in the maxillary sinuses. The mucous membrane is very tumefied, thickened, and injected—more rarely sphacelous at some points. The meninges are sometimes hyperæmic, and there is serous effusion into the two cerebral ventricles. When the larvæ are very numerous, some are dead, and others may be encountered in the larynx and trachea, where they had probably wandered after the death of their host.

Bracy-Clark states that young and old larvæ are generally present together. Butchers, farmers, and others often state that the larvæ have been found in the cranial cavity, and even in the brain-substance, and Cobbold received some carefully-recorded cases in which they had been met with in that organ ; it is possible that, through absorption of the cribriform plate of the ethmoid bone, they may, in rare instances, find their way there.

Prophylaxis.—With the view of preserving Sheep from the attacks of the Œstrus, it has been recommended to keep them from

grazing — from the end of June to the end of September — on pastures bordered by underwood or trees; or to remove the scrub that harbours the flies; or to smear the nose of the Sheep with empyreumatic oil or tar—a tedious operation in a large flock, and one which has only an ephemeral advantage. It has also been advised that, as soon as the shepherd sees the fly about the flock, he ought to clean around the nostrils of the Sheep, so as to remove the larvæ that may have been deposited there—an onerous prescription that stands little chance of being carried out. A more practical measure is to destroy all the larvæ found on making autopsies of Sheep, or which have been ejected from them during life, to limewash the sheepfolds from time to time, and to resort to fumigations during the absence of the Sheep, so as to kill the adult flies which may have taken refuge there.

In invaded localities, or during seasons of extreme prevalence, it might be advisable to apply non-poisonous dressings—such as fish-oil—around the muzzle of the Sheep. Automatic application of this material, Stockholm tar, or any other similar substance, might be tried by adopting Walker's plan; which is to place rock or culinary salt in a long box covered by a lid, perforated with round holes about two inches in diameter, the upper surface and margin of the holes being smeared with the repellent substance; so that every time the Sheep seek the salt—of which they are very fond—they involuntarily receive a dressing on the parts to be protected.

It may be mentioned that the belief is entertained that flocks fed where 'broom'—*Cytisus scoparius* — is in flower, are seldom troubled by the Œstrus. It is known that Sheep are very fond of this plant, the pods of which they eagerly devour, and these produce in them a kind of intoxication. They lie down and appear to be unable to walk; but this soon passes off, and leaves no inconvenience behind.

Treatment.—Many kinds of treatment have been made known, but very few have yielded altogether satisfactory results.

Errhines do not cause more vigorous sneezings than do the larvæ, and yet they are ineffectual in expelling the deeply-seated parasites. The best of the sternutatory powders are tobacco snuff and the rhizome of white hellebore. The shepherd introduces the powder several times a day by his fingers into the nostrils of the affected Sheep, or it may be blown into them by means of a quill. Such powders can only be useful when the young larvæ are migrating, as they generally remain for several weeks in the nasal cavities before seeking the sinuses.

Injections are unsatisfactory. These are usually composed of empyreumatic oil suspended in vinegar and water, or salt and water. Bénion recommends injections of a mixture of ether and oil of turpentine; the employment of these, however, must excite violent irritation in the nasal cavities. Pyrogenous fumigations are unreliable.

All these medicaments can only disturb the larvæ—they may cause them to be displaced, but will not kill them ; for they have great powers of resistance, as Fischer long ago demonstrated. Injections would perhaps cause the departure of the larvæ, if they could be introduced directly into the sinuses by means of trephining, or even resection of the horns.

Zürn indicates the following operation : Draw a transverse line, with coloured chalk, in the middle of the two supra-orbital processes, and divide by another longitudinal median line ; then trephine in each of the two upper angles so obtained, without impinging on the lines—the operation being performed according to the ordinary rules of surgery. The larvæ often creep out through these artificial openings, and they should then be carefully destroyed. Those which are accessible ought to be removed by means of forceps, and the others may be killed by an injection of benzine diluted with water, this being an agent the parasites resist badly. The flaps of skin are then well cleansed, replaced, and fixed by two or three sutures, over the whole being laid a piece of leather steeped in oil of turpentine. The Sheep operated upon is separated from the flock for a few days. Robust Sheep seem to suffer as little from this operation as they do from ear-marking, or any other trifling operation (Zürn).

When there is reason to believe that the larvæ are in the diverticuli running from the frontal sinus to the horn-cores, we may amputate the horns close to the forehead, and extract the larvæ, or kill them by injection, applying a turpentine bandage over the wounds afterwards. Sometimes it suffices to apply the trephine at the base of each horn, and inject through the openings.

Surgical intervention is the most efficacious measure for gettiug rid of the larvæ, and it can be had recourse to more especially in the case of valuable animals. But a complete result cannot always be reckoned upon, as the larvæ are often not collected in the frontal sinus, and those in the maxillary sinuses escape the injections. Zürn says he has many times opened the frontal sinus, and notwithstanding the extraction of from six to ten larvæ, after a transitory amelioration the symptoms have reappeared. Generally, when only a few animals are attacked they are carefully watched, and those which show serious symptoms are sent to the butcher.

Steel asserts that inhalation of the fumes of burning tar mixed with those of sulphur causes early expulsion, and proves particularly useful when resorted to for animals showing early indications of invasion. Exhibition through the nostrils of a mixture of glycerin and oil of turpentine has been found beneficial.

Œstrus of the Camel.—*Œstrus cameli* var. *Pharyngobalus.*—Besides the *Œstrus* or *Cephalomyia ovis*, there are other Bot-flies that attack animals, their larvæ invading the upper air-passages of Deer, Goats, and other hoofed Mammals. The ova of one of the species which attacks the Fallow-deer are deposited in the nostrils,

and the larvæ make their way in large numbers to a cavity near the pharynx. Reindeer are much tormented by a similar species, the larvæ of which infest the cavities of the head, and sometimes cause much destruction.

The Camel often suffers from the attacks of its Œstrus, and in India—particularly during the campaigns in Afghanistan, and in North Africa—Nile expeditions—the Camels in the British armies have experienced great inconvenience. The continuous irritation produced in the nasal cavities and pharynx—marked by snorting, perpetual shaking of the head, an offensive sanguineous discharge from the nostrils, dulness of the animal, loss of appetite, and exhaustion—led, in association probably with other causes, to much mortality.

According to Steel, the Camel Bot is half as large again as that of the Horse, is much softer and more tapering towards the hookless extremity, but broader, rounder, and more compressed towards the hooked end; it is also flattened on its inferior surface, convex on the superior. This authority gives a particular description of the larva, comparing it with that of the Horse-fly.

CHAPTER II

PARASITES OF THE TRACHEA, BRONCHI AND LUNGS

THE most remote parts of the respiratory apparatus may be invaded by numerous parasites. For some, they are an accidental and, in a way, a facultative *habitat*; for others, they are a necessary lodgment. Among the first, there are those that are only exceptionally found, and they will be merely mentioned here; on the contrary, however, there are some which are most important, and which will be the object of special notice so far as their parasitic action is concerned—these are the Echinococci, Distomata, and Nematodes.

Cysticerci.—The *Cysticercus tenuicollis* Rud., a parasite of the serous membranes, has been observed, in the very young state, in the parenchyma of the lungs of Lambs, Kids, and Pigs which had ingested the mature segments of the *Tænia marginata* (Baillet, Leuckart, Railliet). Boudeaud witnessed a similar instance in the Pig, as the result of spontaneous infestation.

The *Cysticercus cellulosæ* Rud., which is a parasite of the connective tissue, has sometimes been met with in the lungs of the Pig and Dog, and the *Cysticercus bovis* Cobb. in those of the Ox (see *Measles*).

Linguatula.—The *Linguatula tænioides* in the larval condition may be found in the lungs of various herbivora and of the Cat.

Acarina.—At the autopsy of a Rabbit, Villemin found 'the two lungs full of numerous granules, about the size of a hemp-seed; they were grey, transparent, slightly yellow in their centre, and projected from the surface of a section of the lung.' He thought at first that it was a case of true tubercle; but on a microscopical examination he found in each granule, which formed a cyst, a dead 'acarus.' 'When compared with several individuals of its species, it appeared to us to be the Acarus of the Horse.' Although Villemin does not mention it, it is probable that this Rabbit was, or had been, affected with auricular acariasis, due to the *Psoroptes communis* var. *cuniculi*. These Psoroptes—similar to those of the Horse—must have, after perforation of the membrane of the tympanum, passed from the Eustachian tube into the air-passages, where, in the lungs, their dead bodies played the part of an irritant foreign body.

ARTICLE I.—Pulmonary Echinococcosis.

The species liable to hepatic echinococcosis (see p. 431) often show also, and generally coincidently, pulmonary echinococcosis. Instances of this condition have been observed in the Horse and

Ass. Among cattle slaughtered in Berlin, Echinococci are found more frequently in the lungs than in the liver.

Steel states that hydatic cysts are of very frequent occurrence in the Camel, and one writer of authority has not hesitated to term them 'a very common cause of loss among Camels.' They are observed in the lungs, liver, and spleen, and are from the size of a pea to that of a cricket-ball. They have also been met with in the lungs of the elephant.

The study of pulmonary echinococcosis in bovine animals is particularly interesting, because of the importance of establishing a differential diagnosis between it and contagious pleuro-pneumonia and tuberculosis. What follows here more especially concerns the larger ruminants, though it is applicable, with some shades of difference, to the other species.

Symptoms.—The presence of Echinococci in the lungs is only betrayed by serious functional disturbance, when they are numerous and of large volume in the two pulmonary lobes.

The first symptoms are a feeble, wheezing cough—at first rare, then becoming more and more frequent, until it is repeated every five or ten minutes. At the same time, the respiration is quickened and interrupted, and there may be slight fever. Pressure on, or percussion of, the chest rarely causes pain ; but percussion elicits a dead sound in places—though it is not so deep or dull as in pleuro-pneumonia. The vesicular murmur is absent in the invaded regions ; but in the others it is stronger, rougher and mingled with *sifflements*, buzzing, or gurgling sounds, and interrupted bronchial *râles* corresponding to the inspirations, and also with a particular characteristic sound at the precise moment when inspiration ceases—the *cloc-cloc* of Hartenstein. Dyspnœa sometimes occurs suddenly, or it acquires its greatest intensity when the animals have been exposed to heat, are fatigued, or have been running—even for a short time. When the lungs are very much invaded by the Echinococci, there may be also noted those disturbances in nutrition already mentioned as present in echinococcosis of the liver, which generally accompanies that of the lungs.

Hartenstein says he has only seen the disease develop itself during summer weather, and in animals turned out to graze ; when they returned to their homes, it became less marked, and finally disappeared.

Lesions.—On opening the thorax, the lungs appear as if enlarged in size, though they are slightly collapsed in places, and are here and there lumpy and marbled—presenting, in fact, if allowance be made for difference in structure, the macroscopical lesions and the different kinds of Echinococci observed in the liver. The weight of the lungs may be increased to 40 or 50 pounds (Ringk, Friedberger aud Fröhner), and even to 54 pounds, according to Morot, six pounds being the normal weight. The volume of the hydatic cysts varies from that of a pea to the size of a man's fist ; around them the parenchyma is compressed and atrophied ; but elsewhere

it is normal. The air-vesicles may open into the bronchi, and their cavity then takes the characters of a pulmonary cavern. Reynaud says he has found acephalocysts developed in the interior of the bronchial terminations in the lungs of a Cow, Deer and Gazelle; but his observation is doubtless incomplete, and the instances ought to be looked upon as not primary, but accidental communications.

Hartenstein thinks he has proof that the hydatic cysts are developed during the summer, and are destroyed in the autumn; but the experiments of Leuckart demonstrate that it requires at least five months for the Echinococci to form heads, so that their destruction requires a longer time than Hartenstein allows. But it takes place sooner or later, as the result of modifications that occur in the adventitious cyst of the Echinococcus; its inner surface—which had for a long time been smooth and transparent—becomes dull and covered with a caseous matter, the layers of which compress the vesicle. The membrane of the hydatid undergoes fatty degeneration; the internal fluid gradually exudes through it and mixes with the peripheral caseous matter, which becomes thicker and more concrete. The hydatid contracts, shrivels up, becomes wrinkled, and forms a gelatinous, and finally an amorphous mass. Often the internal surface of the cysts is impregnated with lime salts, especially the carbonate; and it is the same with the remains of the parasite. Berthold—quoted by Leuckart—has analyzed the calcareous shell of a pulmonary Echinococcus from an old Dromedary, and found two concentric layers in it: an external, the hardest, consisting of phosphate of lime, and an internal of carbonate, with here and there crystalline deposits. An Echinococcus of the largest size may, in this way, be gradually reduced to a simple nodule.

At first sight, a lung invaded by Echinococci might be mistaken for a tuberculous one. But a close examination will show the absence of true tubercles, the presence of hydatids which still preserve all their characters, or the persistence of the hooks in the mass undergoing regressive phenomena.

Diagnosis.—Echinococcosis of the lungs is distinguished from tuberculosis more particularly by the characteristic gurgling sound, and the more laboured respiration occurring in an animal exhibiting all the indications of good health; as well as by the enlargement of the liver, which may be ascertained by rectal exploration.

It might be easily mistaken for pleuro-pneumonia; but the diagnosis of echinococcosis is based more especially on the absence or slight degree of fever, the plumonary sounds, the duller resonance on percussion, and the less sensibility of the chest.

The best course to adopt with animals severely affected is to send them to the butcher.

ARTICLE II.—**Pulmonary Distomiasis.**

The hepatic Fluke, so frequent in the bile-ducts of the Sheep, Ox, and other animals is sometimes found wandering in the lungs. The larger number of facts of this kind pertain to the Ox, and are derived from various countries.

Morot—to whom we owe the most complete researches on this subject—inspected 2,458 Cattle in six months at the abbatoir of Troyes, France, and found hepatic Distomes in the lungs of 101—or a little more than 4 per cent. Of these 101, 93 were more than five years old, and in many of them these parasites were also met with in the liver, in variable number.

The lung Flukes are contained in cysts that usually occupy the posterior lobe of one of the lungs—more particularly the base and towards the borders; being near the surface of the organ, they sometimes form a slight projection from it. Most frequently each animal shows only a single cyst, although the number may be as high as ten.

The volume of these cysts varies in size—being as large as a walnut to an apple—and their shape is globular or ovoïd, rarely discoïd; they are limited by a fibrous capsule of a greyish-white colour, more or less rosy, and sometimes encrusted with lime-salts. Their cavity is generally closed, and rarely communicates with the bronchi; they have at times septa, which divide their interior into angular spaces. The smaller cysts contain a reddish, yellow, or brown syrupy fluid; the larger have a glutinous, and more or less *thick magma, which is sometimes of a uniform, sometimes variable*, streaky tint; or they have a very thick pultaceous, scarcely viscid mass, having the same colour as the magma; or it may be a cheesy, more or less clotted, yellowish or streaky substance.

Each cyst contains one Fluke, rarely two, the parasite being usually small—13 mm. long and 3 mm. to 7 mm. broad; it is often difficult to discover in the fluid surrounding it, which has the same colour. *In some instances it cannot be found*, and only the ova of the Distomata are met with, as Lindqvist has remarked; it is probable that the worm has died and been absorbed, or it has emigrated. Friedberger admits, in fact, that the parasites pass into the pulmonary veins, and are carried by the circulation into the most varied organs.

Pulmonary distomiasis is not betrayed by any appreciable symptom; but according to Bollinger, Lydtin has witnessed a malady in a large number of Cattle, that began like pleuro-pneumonia, and at the autopsies he found here and there—in the ectasiated bronchi—numerous hepatic Distomata.

The cysts of Distomata have also been sometimes found in Sheep, showing the same characters as in the Ox. In three Sheep, Bollinger saw hæmorrhagic centres and galleries containing young Flukes, the immigration of which was certainly recent. Burke has met

with pulmonary distomiasis in a Camel, in India. Distomata have been found in the lungs of Cattle, Dogs, Cats, and Pigs in the United States.

ARTICLE III.—Bronchial and Pulmonary Strongyloses.

The domesticated animals, and especially the herbivora, are exposed to more or less apparent diseases produced by Nematodes in the bronchi or in the whole pulmonary parenchyma. With some rare exceptions—which will be indicated in their proper place—these Nematodes belong to the genus *Strongylus* (Müller—see p. 279); hence the name *Strongylosis*—bronchial or pulmonary—now applied to the maladies they determine.

The Strongyles of the air-passages are distinguished from the other species of the same genus, as Leuckart has remarked, by their embryos, which have a slightly-developed œsophageal bulb, are destitute of teeth, and cannot grow in water by ingesting the matters suspended in it. In the Strongyles of the digestive passages, on the contrary (*Sclerostomum* and *Anchylostomum*), the embryos have a well-developed œsophageal bulb, are provided with three chitinous teeth, and may be nourished and grow at the expense of the organic matter contained in stagnant water.

There are eight known species of Strongylus which live in the air-passages of various domesticated Mammals. The *Strongylus minutissimus* Mégnin, which causes verminous bronchitis in African Sheep, is only a form of *Strongylus rufescens*, as Railliet has shown.

1. **Strongylus filaria** (Rud.—Figs. 305, 306).—A very long filiform worm, somewhat attenuated at the extremities, and of a white colour. Head obtuse, and having no wings; mouth circular, and destitute of papillæ. *Male*, 3 cm. to 8 cm. long; caudal pouch, elongated, notched in front; the posterior ribs trifid, middle ribs simple, and anterior ones bilobate. Spicules short, thick, and winged. *Female*, 5 cm. to 10 cm. long; tail straight and conical; vulva situated behind, towards the third fifth of the length of the body. Ovoviviparous. Embryos 540 μ long by 20 μ in diameter, tapering to a blunt point behind, and having a kind of tubercle at the end of the cephalic extremity. *Habitat*, the bronchi of the Sheep, Goat, Dromedary, Camel in India, Roe-buck, Fallow-deer, Argali, and Gazelle.

2. **Strongylus rufescens** (Leuck., *Nematoideum ovis* (*pulmonale*) Diesing, *Pseudalius ovis pulmonalis* A. Koch, *Strongylus ovis pulmonalis* Curtice—Figs. 307, 308, 309).—A filiform reddish-brown worm; mouth surrounded by three papilliform lips. *Male*, 18 mm. to 28 mm.; caudal pouch excised behind and slightly notched on each side in front; posterior ribs not very distinct, the middle double, the anterior cleft. Spicules arched and striped transversely. *Female*, 25 mm. to 35 mm.; tail terminating in a blunt point; vulva situated at the base of a small pre-anal eminence. Oviparous; ova ellipsoid, and from 75 μ to 120 μ long by 45 μ tu 82 μ broad. *Habitat*, the bronchi of the Sheep, Goat, and Roe-buck.

3. **Strongylus micrurus** (Mehlis—Fig. 310).—Body filiform, very long, and tapering at the extremities. Head rounded and not winged; mouth round and nude. *Male*, 4 cm. long; caudal pouch small, entire, and suspended on each side by five ribs, the posterior of which is tridented, the anterior bipartite, and the others simple; spicules short and strong. *Female*, 6 cm. to 8 cm. long, with a short sharp tail; vulva situated towards the posterior sixth of the body. Ovoviviparous. *Habitat*, the bronchi of bovine animals, the Horse (?), and the Ass (?).

4. **Strongylus pulmonaris** (Ercolani).—Length 1 cm. to 4 cm. Mouth surrounded by a crown of small subspherical papillæ. *Male*, thicker behind than in front; the caudal pouch semi-campanulated, and sustained by seven ribs. *Female* has very thin, oblique, mucronated tail. Ovoviviparous. *Habitat*, the bronchi of Calves.

5. **Strongylus Arnfieldi** (Cobbold—Figs. 311, 312, 313).—Body filiform and white. Mouth nude and orbicular. *Male*, 28 mm. to 36 mm. long; caudal pouch short and faintly lobulated, anterior ribs being bifid—the anterior branch a little shorter than the posterior—the middle ones bifid, the branches equally long, and the posterior ribs thick, bilobate at their end, and widely united at the base. Spicules slightly arched, reticulated, from 200 μ to 240 μ

FIG. 305.—*Strongylus filaria*; natural size.
A, male; B, female.

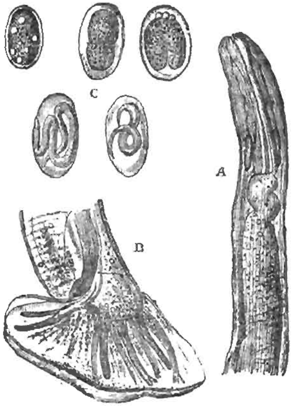

FIG. 306.—*Strongylus filaria*.—Delafond.
A, anterior extremity, showing the œsophagus, so-called salivary glands, and the origin of the intestine; B, caudal pouch of the male; C, ova at different stages of development; magnified 120 diameters.

long, and accompanied by an accessory short piece of a pale-yellow tint. *Female*, 45 mm. to 55 mm. long—90 mm. according to Cobbold—with a short, slightly-curved tail terminating in a blunt point. Vulva non-salient, situated at the anterior three-fifths of the body. Ova 80 μ to 100 μ long, and 50 μ to 60 μ broad. Ovoviviparous. Embryos 400 μ to 490 μ long by 14 μ to 28 μ broad, and provided with a small, thin, and transparent caudal appendage. *Habitat*, the bronchi of the Horse and Ass (Railliet).

6. **Strongylus paradoxus** (Mehlis, *St. elongatus* Duj.—Fig. 314).—Body relatively short, and white or brown. Mouth encircled by six lips, the two lateral being the largest. *Male*, 16 mm. to 25 mm. long; caudal pouch deeply bilobate, each lobe being sustained by five ribs. Spicules slender and very long. *Female*, 20 mm. to 40 mm. long, with curved and mucronated tail;

vulva situated on a pre-anal eminence. Ovoviviparous. *Habitat*, the bronchi of the Pig and Wild Boar, and also of the Sheep, according to Koch.

7. **Strongylus commutatus** (Diesing).—Head rounded. Mouth with three very small papillæ around it. *Male*, 18 mm. to 30 mm. long; caudal pouch cordiform, and sustained on each side by five short ribs. *Female*, 28 mm. to 32 mm. long, and having a conical tail; vulva situated immediately in front of the anus. *Habitat*, the bronchi of Hares and Wild Rabbits; rarely seen in the domesticated Rabbit.

8. **Strongylus pusillus** (V. Müller).—Body filiform. Mouth nude and without papillæ. *Male*, 4·9 mm. long; caudal pouch short and slightly festooned, its anterior ribs being bifid, the posterior divided, and the others simple; spicules long and slender. *Female*, 9·6 mm. to 9·9 mm. long, with a short tail terminating in a blunt point. Vulva non-salient, and situated a little in front of the anus. Ova globular, and from 50 μ to 70 μ in diameter. Oviparous. Embryos 270 μ to 350 μ long by 17 μ to 23 μ broad, and provided with a small, thin, transparent caudal appendage (Fig. 317). *Habitat*, the bronchi of the Cat.

1. Verminous Broncho-pneumonia of the Sheep and Goat.

Strongylosis of the air-passages is frequent in the smaller Ruminants, especially the Sheep, and it is manifested at one time in the form of bronchitis, another time in that of pneumonia, and at another time again—and that oftenest—as broncho-pneumonia. These forms of disease are subordinate to the zoological species of the worms causing them, and to the more or less superficial or remote

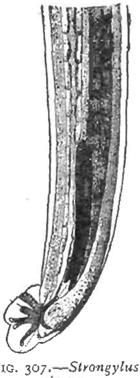

Fig. 307.—*Strongylus rufescens.*

Caudal extremity of the male; magnified 100 diameters. —Railliet.

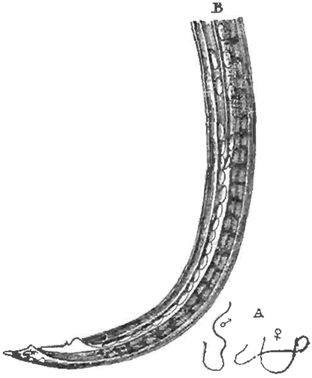

Fig. 308.—*Strongylus rufescens.*

A, male and female; natural size. B, caudal extremity of the female; magnified 50 diameters.—Railliet.

habitat of these entozoa. This disease—which appears to have been first observed in 1768—and then in epizoötic form—by Daubenton, in the flocks of Sheep at Bourgogne, has often ravaged the various countries in Europe, and has formed the subject of numerous memoirs.

Symptoms.—Bronchial strongylosis and verminous pneumonia often co-exist in the same Sheep, so that it is difficult to decide as to the part each plays in the evolution of the symptoms that mark the disease. But pulmonary strongylosis leaves the animals it attacks more indifferent, while the manifestations of parasitic broncho-pneumonia are usually due to the bronchial strongyle. Otherwise, the symptoms of this malady vary much in their intensity, and not unfrequently lesions are found at the autopsy of animals which during life appeared to be in good health. What often causes the affection to remain unperceived, is the fact of its often coinciding with distomiasis, which alone attracts attention. But, generally, broncho-pneumonia, or at least verminous bronchitis, may be recognised by a distinct group of symptoms.

Strongylosis of the air-passages of Sheep appears at all seasons ; but it is more particularly observed from the month of March, until September or October. In its bronchial form it attacks young animals—Lambs and year-olds—by preference, while verminous pneumonia is more often developed in adults.

At the commencement of the attack, the symptoms are slight and fugitive ; but they become more marked as the bronchi are invaded. The affected animal manifests all the signs of a violent bronchial catarrh—painful, difficult dyspnœic respiration ; a strong, plaintive, painful and convulsive cough, coming on in fits, chiefly during movement, and producing a degree of suffocation that leaves the animal prostrate. There is a thick and abundant discharge from the nostrils, and masses of mucus are often expelled during the attacks of coughing ; in these matters, numerous Strongyles and embryos are usually found. These symptoms become more acute, and notwithstanding that the appetite is preserved, the Sheep lose condition, fall into a state of consumption and anæmia—recognisable by the pallor of the skin and visible mucous membranes, and dryness of the wool ; diminution of the respiration is the essential cause of this. Death occurs from cachexia or asphyxia at the end of two, three or four months—according to the strength of the animals and the care they receive. When the symptoms are very well marked, recovery can scarcely be looked for unless the worms are in small number, and the animal is sufficiently vigorous to expectorate. The disease is most intense in the autumn, and if it does not cause death, it becomes attenuated in winter, and usually disappears in the spring, unless there is new infestation.

Prognosis.—The verminous broncho-pneumonia of Sheep may remain unperceived—so slight are the signs by which it might be manifested—and its existence be only revealed in the abattoir. But when it is betrayed by the array of symptoms just enumerated,

it is always a serious affection—usually fatal—and one which, in any case, much depreciates animals in value. And what renders it still more serious, is the circumstance that it is often present in an epizoötic—and even an enzoötic—form, causing great damage to Sheep-rearing.

Pathological Anatomy.—At the autopsy, the lesions of asphyxia and cachexia are noted—general emaciation, scanty and watery blood, serous effusions into the peritoneal, pleural, and pericardial sacs, and generally numerous Flukes in the liver. But there are always pulmonary lesions directly due to the presence of Strongyles, which may belong to three distinct species—*Strongylus filaria*, *St. rufescens*, and *St. paradoxus*. We ought to mention here the finding by Ebertz of very lively Nematodes in the lungs of a year-old Sheep, and, according to Leuckart, they were the larvæ of a Strongyle or Filaria. A little smaller than the muscular Trichinæ, and not striped transversely, they resembled these before their encystment. The lungs were somewhat more serous than in health, and rough and dull on the surface. The worms were also met with in the muscles and kidneys. The Sheep had presented signs of debility, paresis of the limbs, muscular tremblings, frequent falls, anæmia, and paroxysms of coughing. Leuckart—to whom these parasites were submitted—has declared he had only once before seen such a worm; it had been obtained from the lymphatic glands of an Ox affected with melanosis.

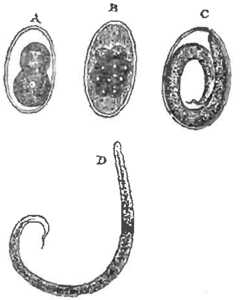

FIG. 309.—Ova and embryos of the *Strongylus rufescens*; magnified 150 diameters.—Railliet.

A, B, ova in process of segmentation; C, ovum containing an embryo; D, free embryo.

The *St. filaria* and *St. rufescens* are the most widespread. The *St. paradoxus*—which is considered as specially belonging to the Pig and Wild Boar—has been found at Vienna, by Koch, in the verminous bronchitis of the Sheep, in which it played the part of the *St. filaria*; but as it is only exceptionally encountered, we will limit ourselves to studying the effects of the *St. filaria* and *St. rufescens*. These two parasites—which often co-exist in the same individual—do not comport themselves in the same way, the first living in the bronchi and giving rise to bronchitis; and the second partly operating in the pulmonary vesicles, and causing pneumonia.

In *Verminous bronchitis*, the bronchi are sinuous, and offer sacciform dilatations—which are sometimes considerable—in which

bundles of worms are found interlaced, and mixed with more or less purulent mucus. A microscopical examination of this mucus shows numerous embryos moving about in every direction. The plugs of worms and mucus penetrate the bronchioles, and ascend into the trachea, partially obstructing their lumen. There are often inflammatory streaks on the surface of the bronchial mucous membrane, and in the vicinity of the bronchial dilatations the pulmonary tissue is compressed, obliterated, and pale. The lungs have often contracted local adhesions by their serous covering.

Verminous pneumonia often accompanies parasitic bronchitis, and is due to the *St. rufescens*, which, in the adult state, is met with in various degrees in the bronchi. It may wander as far as their ultimate ramifications, by stretching itself out, as it were, and fix itself in the pulmonary parenchyma; then we find one or more individuals in the form of very fine twisted filaments, and it is in this condition that Koch has described it as a distinct species, under the name of *Pseudalis ovis pulmonalis*. Railliet has demonstrated that it is nothing more than a form of *St. rufescens*.

Verminous pneumonia caused by the *St. rufescens*—either in the adult condition or as ova or embryos—may present itself in the three forms distinguished by Bugnion: 1. A *lobular* pneumonia produced by the adult Strongyles arrested in the bronchi; 2. A *diffuse* pneumonia, due to ova and embryos disseminated by thousands in the parenchyma, which realizes what Bollinger has termed 'exudative pneumonia'; 3. A *nodular* or *pseudo-tuberculous* pneumonia, in which the ova and embryos occupy circumscribed points in the parenchyma—that is the most frequent form.

This nodular pneumonia is constituted by distinct centres the size of a millet-seed to that of a pea, of a greyish-yellow colour and semi-transparent, or of a more or less intense dark-red hue, according to their age and the acuteness of the inflammatory phenomena. The consistence of the dark-red nodules is not so great as in those of a yellow colour, and in the latter it diminishes from the centre to the periphery. Generally, in all except the oldest they adhere to the surrounding tissue, from which it is impossible to enucleate them. All these centres may assume a caseous character, and even undergo calcareous infiltration. The majority occupy the periphery of the lungs, and particularly the borders, while many lie immediately beneath the visceral pleura.

These nodules owe their production to the ova that the females of *St. rufescens* deposit in the pulmonary alveoli, where they pass through all the phases of their development. The result of this deposition is a series of special inflammatory phenomena—the walls of the invaded alveoli undergoing an abundant infiltration of embryonic elements, and so acquiring a very great thickness, the infiltration extending some distance beyond the spot. This change appears as a network, each mesh of which contains an ovum in one or another stage of development. The epithelium in

these inflammatory formations is almost null, except in those exceptional instances in which the ovum has not quite filled the alveolus, and the space left free is then filled with epithelioïd cells (Laulanié). After the ova are hatched, the embryos set free engender a much greater amount of irritation, which leads to the production of a miliary pneumonia, that may present itself in all its forms, from hæmorrhagic to purulent. The scraping of sections gives a foamy fluid, in which are found a large number of ova and embryos—the latter measuring 300 μ to 400 μ long by 16 μ to 20 μ broad; the caudal extremity being very slender, and terminating in a short, undulated, fine point. Very often in the small nodules there are adult, or nearly adult, worms (Baillet, Colin, Bewley, etc.).

Etiology, Evolution.—Verminous bronchitis and pneumonia have analogous conditions of expansion, although the *St. filaria* and *St. rufescens* have not the same mode of development.

The *St. filaria* is ovoviviparous, but the embryos directly thrown out by the females into the bronchi of their host do not appear to develop there, and it is probable they require to be expelled from the animal in order to pass through the first phases of their existence. Ejected with the bronchial mucus, they may—if they fall into water—remain alive for several months (Baillet, Colin), provided the liquid does not undergo putrefaction because of the organic matters suspended in it (Railliet). In the course of the second week they moult, and this brings about the disappearance of the cephalic knob with which they were provided; they then appear more attenuated posteriorly, and have a slight greenish tint. It would even appear that they undergo a second moulting, and that the larvæ yet retaining their envelope, and in a manner encapsuled, may resist desiccation for a long time (Leuckart, Railliet); Ercolani went so far as to say that he had seen them become revivified on coming into contact with water, after being dried for a year. This will explain how it is that the malady may appear in Lambs which have had no direct contact with animals suffering from verminous bronchitis, and also how it may continue, as an *enzoöty*, in a country. It is very probable that the embryos enter the body along with the grass of damp pastures, and the water the Sheep drink; and this view is in accordance with the older notions as to the etiology of the malady, which testified to the great influence of humidity in the development of verminous bronchitis. It is chiefly in the springtime and summer that the embryos of the *St. filaria* are disseminated over humid pastures. Leuckart has been quite unsuccessful in infesting Sheep by feeding them with bronchial mucus rich in embryos, and he therefore concludes, from this result, that these embryos—as well as those of all the Strongyles of the air-passages—must pass their first phases in an intermediate host—an insect or mollusc; but this hypothesis is not based on any element capable of demonstration. Cobbold was of opinion that the young of the Strongyles which occasion 'husk,' undergo their primary changes of development either within soft mud alone, or

within the bodies of larval insects and minute entomostracans inhabiting ponds, ditches, and running streams. Nothing is known as to the course followed by the embryos of the Strongyles which have found their way to the digestive organs, in reaching the interior of the bronchi. Zürn teaches—but without any assignable reason—that they pass from the stomach into the œsophagus, reach the pharynx, and then their intrusion into the respiratory organs is easy.

With regard to the origin of verminous pneumonia, this occurs in similar telluric conditions, the embryos of the *St. rufescens* ejected with the mucus being capable of living a long time in a moist medium outside the animal body; they can be kept alive for months in water—Railliet has even seen them resume their activity after three days' complete desiccation.

Prophylaxis.—*Our ignorance of the evolution of St. filaria* and *St. rufescens* renders uncertain any prophylactic measures that may be recommended against the verminous bronchitis of Sheep. As young animals are more susceptible to attack than older ones, it is advisable to feed the Lambs and year-olds in the folds in those countries in which the malady prevails; or, at any rate, they *should not be turned out to pasture in the spring and commencement of summer, when the embryonal progeniture of the worms is distributed over the meadows.* They may be driven on to the stubble-fields until feeding-time in the fold arrives. But if circumstances render it imperative that they must be grazed, care should be taken to break their fast in the morning with a little dry forage; and some clean water ought to be allowed, so that they will not require to drink from ponds or ditches, by which they might be infested by the larvæ these contain.

In order to combat a surreptitious infestation and destroy the embryos as they arrive in the stomach, substances which are toxic for the larvæ are placed within reach of the Sheep during May, June and July—such a substance is culinary salt. Spinola has recommended bread composed as follows:

Sea-salt	500 grammes.
Stockholm tar	of each 1000 ,,
Wormwood	
Tansy	

The substances are pulverized and mixed with flour and water, so as to form a firm paste, which is to be made into flat cakes. These, after being dried in the air, are to be given to the Sheep, along with scorched oats.

Zürn also recommends the following formula:

Wormwood	1000 grammes of each.
Root of *Calamus aromaticus*	
Tansy	500 ,, ,,
Calcined bones	
Sulphate of iron	

These substances should be reduced to powder, and given with scorched oats, in the proportion of 12 to 15 grammes to each Lamb.

Prophylaxis also recognises the utility of drying and draining damp pastures, and the destruction of the lungs of animals killed during the course of the malady.

For the prevention of this disease in the Calf, it has been recommended that infected land should be dressed with gas-lime or soot and crushed rock-salt in the early spring months—5 or 6 cwt. to the acre; also that all rough grasses on old-laid grazing pastures should be mown in autumn and converted into ensilage.

In seasons when the malady is prevalent, Lambs should not be allowed on natural pastures, or old grass-lands previously grazed by Sheep, but if possible put on high and dry grazing-grounds. It is advisable also to separate the diseased from those still healthy. Care should be taken, in introducing fresh Sheep among a flock, that they are not infested, as there is evidence to show that contamination may take place in this way. An instance is recorded in which a Ram was introduced among Ewes in the autumn, and fed and drank with them; the animal died from verminous bronchitis, and the flock subsequently suffered seriously—contamination having taken place, it was supposed, from the water-troughs. Hay from infested meadows may also prove a source of infestation.

Treatment.—Two different procedures in treatment are pursued. In one, substances are passed into the digestive canal, which—being diffused in the blood—are believed to be capable of attacking the worms in the bronchial tubes. With this view, the picrate of potash—·20 to ·40 gramme per head—is given, dissolved in thin gruel or mucilage; creosote; oil of turpentine; a mixture of equal parts of oil of turpentine and tincture of camphor—a teaspoonful in a mucilaginous fluid every day to each Lamb; a mixture of creosote—120 grammes—spirits of wine—500 grammes—and water—700 grammes; an ordinary spoonful every day to each animal; or creosote—60 grammes—benzine—300 grammes—water—2 litres: an ordinary spoonful given every day for eight days to each Sheep. Hall states he has successfully employed prussic acid in ten-drop doses, morning and evening.

But experience has shown that, while such treatment is troublesome to carry out, its efficacy cannot be relied upon.

Success is more certain with fumigations, as they penetrate directly to the worms, stupefy them, and induce fits of coughing which cause their expulsion. They are practised in well-closed buildings from which all forage has been previously removed. Into these the diseased are introduced, and on a red-hot shovel are placed rags, horns, feathers, hair, old pieces of leather, empyreumatic oil, tar, juniper-berries, asafœtida, etc. The intensity, duration, and number of these fumigations are graduated as the Sheep become accustomed to them; at first once a day may suffice, and then the intensity should be moderate, and the duration about ten minutes; afterwards two, and finally three, may be given during the day, each lasting for twenty minutes. Kowalewsky says he has obtained very good results from similar fumigations. Fumiga-

tions with chlorine, sulphur, and sulphuret of mercury or cinnabar, have been recommended; but they are somewhat dangerous.

Stephen recommends as follows: Put about forty Lambs at a time into an air-tight house, and place tar, sulphur and turpentine in a pot of burning coals, suspended by a chain from the ceiling, and brought as near to the heads of the animals as possible; the fumes are to be allowed to fill the house, and more ingredients are added as required — the Lambs being kept in the place for twenty-five minutes each time, and the process repeated on three occasions.

Tracheal injections in the verminous bronchitis of Calves are of great utility; but for a flock of Sheep they would be troublesome and difficult to administer. However, Nieman has successfully employed them on 384 Sheep belonging to several small owners. *He used a solution of 2 parts iodine and 10 parts iodide of potassium, in 100 parts of distilled water. This fluid was mixed, in equal* parts, with oil of turpentine, and made into an emulsion with olive-oil; each Sheep received 5 to 8 grammes of the mixture, and the number of injections varied according to the gravity of the disease—from 2 to 3 at two days' interval. The worms were killed and expelled during the paroxysms of coughing, and the bronchitis was modified.

The medical treatment should be assisted by very nourishing food, and by bitter, stimulating, and ferruginous tonics, which arouse the digestive functions and allow those animals which are least exhausted to reach the period of elimination of the parasites.

At the commencement of any kind of treatment, it is well to have an examination of the flock, with the object of sending the worst cases to the butcher.

2. Verminous Bronchitis of Bovines.

The verminous bronchitis of Calves is that which was first observed. Ruysch had, so long ago as 1744, noticed worms living in the air-passages of these animals; but Nicholls was the first—in 1756—to speak of a disease caused by these entozoa, which prevailed in an epizoötic form in England. Camper also alluded to a similar occurrence in 1803. Since that date it has been often observed and described.

Symptoms. — When the Strongyles are not numerous, the symptoms are only an infrequent, slight, and sonorous cough occurring in fits; it becomes gradually stronger, broken and husky, and at last comes on in long paroxysms, accompanied by dyspnœa and suffocation. During these attacks the respiration is hurried, the flanks are agitated, the pulse quickened, and the *conjunctivæ* injected; the animal stretches its neck, extends the head, opens its mouth—the tongue protruding, and saliva flowing from the commissures of the lips. During the most violent paroxysms, the

animal—asphyxiated—falls prostrate on its side, with the eyes protruding and haggard, the mouth gaping, and the tongue pendulous. These fits occur several times during the day, and sometimes the animal dies in one of them. The coughing causes the expulsion, by the mouth or nasal cavities, of mucus that may be streaked with blood, and contains single worms or masses of them, which are readily recognised, more particularly by their movements when they are put into tepid water.

When the disease progresses slowly, the symptoms are milder, but there is also a great alteration in nutrition—emaciation, pallor of the mucous membranes, sunken eyes, debility, dull and staring coat, then partial depilations, phthiriasis, gradual loss of appetite, irregular rumination, diarrhœa, hæmoptysis, fœtid breath, and, finally, fatal marasmus.

The *duration* of the malady varies with its intensity. Death—which is generally brought about by asphyxia or extreme cachexia—may also be due to an intercurrent pneumonia or pulmonary hæmorrhage; it may take place in three, four, or five months. Morier has seen some animals live for a year.

The *diagnosis* is based on the character of the paroxysms of coughing, and more especially on the presence of Strongyles in the expectorated matters. Adult worms may not be present, but their embryos are always to be found, and a microscopical examination will reveal their existence. It often happens at the commencement of the malady, that the animals swallow their expectorations as soon as these arrive in the pharnyx; so that an examination cannot be made. When this is the case, the animal should be compelled to cough, then the tongue is seized by one hand, while the other extracts from the back of the mouth some of the mucus thrown up from the bronchi.

Verminous bronchitis has often been mistaken for contagious pleuro-pneumonia—an error which might have grave consequences, and which an autopsy only could rectify. This mistake might be averted if it is remembered that in verminous bronchitis the respiratory murmur is heard throughout the chest, amid mucus rattles, and that there never is a blowing sound. Percussion gives a resonant, though diminished, sound over all the thoracic parietes.

But it must be insisted upon, that the presence of the Strongyles and their embryos in the expectorations is the criterion of the disease.

The *prognosis* is usually serious, especially when the malady has not been recognised; and the gravity will vary, not only with its intensity, but also with the general condition of the animal and the intercurrent complications.

Pathological Anatomy.—The lesions are analogous to those of the verminous bronchitis of the Sheep. The inflammation of the bronchial mucous membrane is usually more intense; there is nearly always general pulmonary emphysema, with secondary lobular pneumonia. Van Tright has described, in the Ox, a form

of pseudo-tuberculosis analogous to that observed in the Sheep. The worms, which were found in more or less voluminous bundles from the last divisions of the bronchi to the upper part of the trachea, belonged to the *St. micrurus*: the name of *St. pulmonaris* has been given by Ercolani to different worms he found in large numbers in the bronchi of a Calf. Prangé had sent him the identical worm from France, which he had also met with in a Calf.

Etiology, Evolution.—Like the *St. filaria* of the Sheep, the *St. micrurus* is ovoviviparous; and though its development has not been much investigated, yet we may probably apply to it the knowledge we have obtained with regard to the *St. filaria*—the embryos can only become developed after they have left their first host, and *nothing* is known as to the phases they assume before their immigration into a new individual. However this may be, experience has shown—as for the *St. filaria* of the Sheep—the influence of humidity on the appearance of the disease in the bovine species; and it would appear to establish the fact that affected animals may be contagious to those which are healthy (Vigney, Delafond, Janné)—though this requires scientific confirmation. It may be noted as remarkable, that adult animals are rarely attacked, and that Calves most frequently pay their tribute to the affection, which often appears in an epizoötic form.

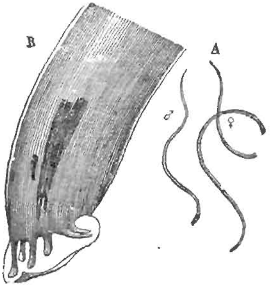

FIG. 310.—*Strongylus micrurus.*

A. male and female; natural size; B. caudal extremity of the male; magnified 100 diameters.—Railliet.

Prophylaxis.—This is the same as for the verminous bronchitis of the Sheep (see p. 501).

Treatment.—The same medicaments have been employed in treating this malady in Calves as in that of Sheep, and no better results have been obtained. Numan and Janné have, however, been successful with asafœtida (30 grammes), Chabert's empyreumatic oil (60 grammes), and a mucilaginous decoction (500 grammes)—a spoonful of this mixture being given daily in a half-litre of milk, and the treatment continued for about a month.

The results are less uncertain if the worms lodged in the bronchial tubes are directly acted upon, either by means of fumigations of the same kind as those employed for Sheep, or fluid medicaments introduced directly into the bronchi.

Read says he has cured Calves reduced almost to skeletons by

verminous bronchitis, by the following procedure: The head of the Calf is slightly elevated, and two teaspoonfuls of a mixture of ether, 60 grammes, and rectified oil of amber, 2 grammes, are poured into each nostril, and allowed to vaporize there. Oil of turpentine may be substituted for the amber oil in this prescription. In some cases it must be repeated two or three times, but one dose has frequently the desired effect.

The method of treatment by intra-tracheal injection, introduced by Levi of Pisa, has yielded very satisfactory results. Levi has been completely successful with Sheep. Éloire has employed it in 16 Calves affected with the disease, and all were cured. He used the following mixture:

Black poppy oil	100 parts.
Oil of turpentine	100 ,,
Carbolic acid	2 ,,
Purified cade oil	2 ,,

Each Calf received 10 grammes of this mixture daily for three days.

The injection, which should be given slowly, is followed by a fit of coughing, and the expired air has the odour of turpentine. This treatment has also been successful at Milan. Similar favourable results have followed Hutton's treatment of 8 Calves, some of which were in the last stage of verminous bronchitis. He employed a mixture of oil of turpentine, tincture of opium, pure carbolic acid, and water—the oil of turpentine forming one-half of the mixture. The dose was 15 grammes, and in serious cases this was given every day for three days, and in other cases every second or third day. Kriwonogow has likewise cured 22 Calves, by giving each of them two tracheal injections of 8 grammes of the following mixture: Oil of cloves and oil of turpentine, 360 parts of each; carbolic acid and olive oil, 30 parts of each.

Williams speaks highly of the administration of prussic acid. Penhale gives—by intra-tracheal injection, and slowly—oil of turpentine 2 drachms, carbolic acid 20 minims, and chloroform half a drachm.

3. Verminous Bronchitis of the Camel.

Helminthologists have for a long time known of the presence of the *Strongylus filaria* in the bronchi of the Camel and Dromedary. Piot has reported that this worm may cause an epizoötic verminous bronchitis.

The first symptom is sneezing, which is repeated in short fits, with sighing in the intervals, and at each sigh the larynx is much projected forward; at the end of expiration, which is accompanied by a gurgling laryngeal sound, the head and neck are protruded. Respiration is buccal and nasal, air often distending the cheeks and parotid region, and is swallowed with a noise like hiccough. There is at first a serous, then a mucous discharge from the nostrils, which becomes foamy, tinged with blood, and profuse; it is sometimes accompanied by epistaxis, and contains numerous embryos. There is at first excitement, then sluggishness, cachexia, inappetence, constipation, tympanites, feebler thoracic resonance, and *râles* and blowing sounds. Nearly all those

attacked are affected with labial pruritus, which causes them to rub their upper lip and nose until these are excoriated.

The disease continues for twelve to fifteen days, sometimes a month, and then terminates by recovery or death.

At the autopsy, lesions of bronchitis, and even of pneumonia and pleurisy, are found.

Piot has successfully employed fumigations of tar, and more especially tracheal injections of a preparation composed of oil of turpentine 10 grammes, ether 10 grammes, tincture of opium ·50 gramme, and 1 per cent. carbolized water 20 grammes.

4. Verminous Bronchitis of Equines.

The bronchial Strongylosis of Equines appears to have been seldom seen. Morier has observed it in Horses of all ages in Switzerland, where it prevailed at the same time among Calves from six months to two years old. Eichler collected from the bronchi of a Horse at Berlin, worms which Diesing classed with the *Strongylus micrurus*; and Gurlt attached to that species Nematodes from the bronchi of the Horse and Ass. Cobbold demonstrated that the Strongyles of the bronchi of the Ass form a separate species — the *St. Arnfieldi* — and Railliet recognised that those of the Horse belong to the same species, and completed their description. This rare form of Strongylosis appears to manifest itself by symptoms analogous to those of verminous bronchitis in the other species, is accompanied by similar lesions, and is developed in the same etiological conditions.

Railliet has remarked that the larvæ of the *St. Arnfieldi* do not at all withstand desiccation, and do not live more than eight days in pure water. They can, therefore, only pursue their evolution if they arrive quickly into a suitable medium; and this will explain the rarity of bronchial Strongylosis in the Horse.

An agamous Sclerostome has been found by Morot in a pulmonary vessel of a Horse (Railliet).

Fig. 311.—Caudal extremity of the male *Strongylus Arnfieldi*: magnified 100 diameters.—Railliet.

5. Verminous Bronchitis of the Pig.

The presence of Strongyles in the bronchi of the Pig was noted towards the end of the eighteenth century by Ebel, Gœze, Modeer, Mehlis, etc. They have since then been met with several times by Rayer, Chaussat, Dujardin, Bellingham, etc. They do not appear to be frequent, except in certain regions, and they do not usually cause such grave functional disorders as those remarked in Sheep and Calves.

Chaussat stated, in 1850, that it was usual to find the *St. paradoxus* in the bronchi of Pigs brought to Paris—at least, in certain seasons of the year. Chatin also asserted that this parasite is very common in France. Boudeaud informs us that it is frequent

in young Pigs in the Indre department ; and Modena observed it very often in Pigs in Sardinia and the Maremmes of Tuscany, where verminous bronchitis appears to be enzoötic.

The bronchial Strongylosis of the Pig often remains unperceived, and in the majority of the animals in which Strongyles are found after death, there was nothing observed during life to raise any suspicions of their presence. Sometimes their existence was betrayed merely by cachexia and resistance to fattening. In other cases there was a moist, troublesome coughing fit, and a group of

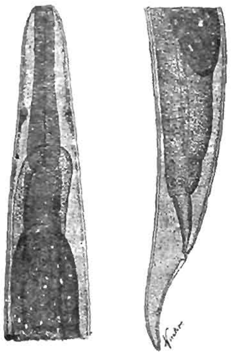

FIG. 312.—Cephalic and caudal extremities of the female *Strongylus Arnfieldi* ; *magnified 100 diameters.* —Railliet.

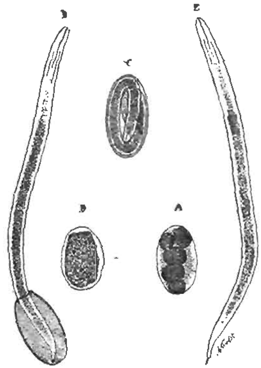

FIG. 313.—Evolution of the *Strongylus Arnfieldi*.—Railliet, *inedited.* *

* A, ovum undergoing segmentation ; B, ovum in the morula stage ; C, ovum with embryo ; D, the embryo being hatched ; E, the embryo hatched ; magnified 150 diameters.

serious symptoms analogous to those we have already depicted for the other domesticated animals. Death may result, and especially in young Pigs—a remarkable instance of which is cited by Deguillème.

At the autopsy there are found the lesions—more or less accentuated—of verminous bronchitis. They are generally slight, and the worms are lodged in the smaller bronchi ; the lungs are the seat of local congestion. Gratia mentions having on several occasions met with verminous pneumonia in the Pig, in the form of pseudo-tubercles having the closest analogy to those which *St. rufescens* gives rise to in the Pig. These broncho-pneumonia nodules

were 'essentially constituted by endo-alveolitis and endo-bronchitis in limited foci.'

The treatment—which should be based on that prescribed for Sheep affected with the same disease—should only be resorted to in the case of valuable young or adult Pigs, as it is more advantageous to kill others for food if their age is suitable.

6. Verminous Bronchitis of the Rabbit.

This disease is extremely rare in the domesticated Rabbit; for the *Strongylus commutatus* almost exclusively infests the bronchi of the wild Rabbit, and especially of the Hare, which it sometimes destroys in large numbers.

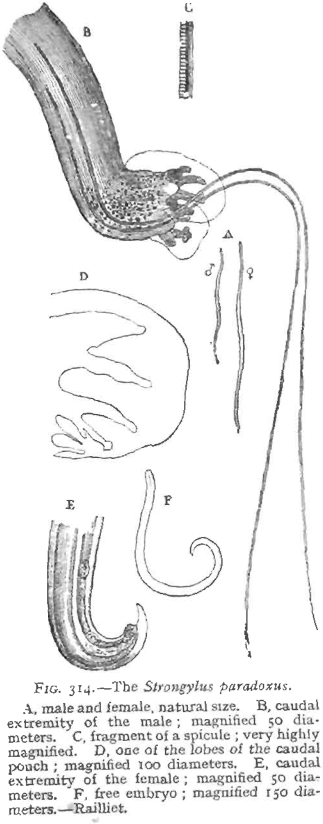

Fig. 314.—The *Strongylus paradoxus*.

A, male and female, natural size. B, caudal extremity of the male; magnified 50 diameters. C, fragment of a spicule; very highly magnified. D, one of the lobes of the caudal pouch; magnified 100 diameters. E, caudal extremity of the female; magnified 50 diameters. F, free embryo; magnified 150 diameters.—Railliet.

Article IV.—**Helminthiases of the Trachea, Bronchi and Lungs of the Dog.**

The worms observed in the trachea, bronchi, and lungs of the Dog are Nematodes, which make the air-passages of this animal their ordinary, accidental, or transitory *habitat*. Several of them are little known as yet.

1. **Tracheo-bronchial Filaria of the Dog.**—There are five observations on record of verminous nodules of the trachea and bronchi, caused by the Nematodes that Blumberg and Rabe doubtfully place in the genus *Filaria*. Of these five observations, one is due to Renault, two to Blumberg, and the other two to Rabe. These nodules are situated in the inferior part of the trachea, at its bifurcation, and in the bronchi towards their origin. Their number is very

variable—from four to a hundred ; while their volume may be from that of a millet-seed to that of a pea. Situated beneath the mucous membrane, which is raised over them, they are generally oval in shape, somewhat flattened, hard, reddish in colour, and slightly uneven. Each of them contains a notable quantity of small Nematodes, which, in passing through the wall, protrude on the surface by one or other of their extremities, and in this way they simulate villi. Their description is as follows :

Body filiform. Mouth surrounded by two or three prominences or concentric lips of variable height, behind which are three unequal papillæ ; pharynx dilated. *Male*, 5 mm. long, with the posterior extremity rounded ; two unequal, curved spicules. *Female*, 9 mm. to 15 mm. long ; vulva situated immediately in front of the anus. Ovoviviparous. These worms, imbedded as they are in the substance of the nodules, are very difficult to extract, and their study is still incomplete.

Their presence is usually not betrayed by any particular symptoms ; though in a case remarked by Rabe there was very marked respiratory disturbance ; the nodules found at the autopsy were very numerous, and were more particularly concentrated in the thoracic portion of the trachea. The lungs also contained a great number of grey nodules, the size of a grain of sand ; they chiefly abounded beneath the pleura, and the largest of them was inhabited by one or more females.

The *verminous bronchitis* described by Osler appears to have been this affection. The parasite to which he attributed it, and which he named *Strongylus bronchialis canis*, was designated *Filaria Osleri* by Cobbold. The largest *males* measured scarcely 4 mm., and the *females* a little more than 6 mm.

Of 30 Dogs attacked by this disease, 21 succumbed to it ; all of them, except six, were not more than eight months old. The principal symptoms were : Inappetence, indifference, weakness ; sometimes paraplegia, often convulsions ; rarely diarrhœa ; vomiting after food ; sometimes a short, husky cough ; and intense fever. Duration, three to ten days. In eight dogs on which an autopsy was made, there were observed lesions of bronchopneumonia, but only in six were parasites found ; these were nearly all lodged in nodules in the tracheal mucous membrane, chiefly at the bifurcation of the tube, and in the larger bronchi, the nodules projecting from the surface of the membrane as in the preceding cases. A certain number of adult Nematodes and embryos were concealed in the mucus of the smaller bronchi. The lining membrane of the trachea was highly hyperæmic. It might be questioned whether all these cases were of the same kind, and if they did not rather coincide with the ' distemper ' of young Dogs, localized in the respiratory apparatus. The details given would support this hypothesis.

Courtin, of Bordeaux, has also met with Nematodes in the bronchi and pulmonary vesicles of the Dog ; but these were embryos the origin of which could not be determined. The inferior lobes of the lungs showed, posteriorly, patches of white, indurated substance in which were found embryos—some free, others encysted. Mégnin reports having observed a similar instance in a Fox-terrier.

2. **Filaria immitis** (Leidy).—This worm inhabits the right side of the heart and the pulmonary artery, but it may be met with in making sections of the lungs (see *Hæmatozoa of the Dog*).

3. **Spiroptera sanguinolenta.**—This entozoōn lives in tumours in the œsophagus and stomach of the Dog ; nevertheless, it may also be fonnd in the walls of the aorta, whence it throws off its embryos into the blood, by means of the pulmonary vessels. Railliet has seen a tumour in a Dog's lung which contained several of these worms. The lung adhered to the œsophagus, which had a similar tumour at the same level.

4. **Indetermined Nematode.**—A white, round, filiform worm, tapering at both ends ; head and tail without wings ; length 4 cm. to 5 cm. Found by Chauvrat in Algeria, at the autopsy of a Dog which had been killed because of rabiform symptoms. The bronchial glands contained 20 to 25 specimens—some of them twined round each other in bundles, others separate. Several were found in the bronchi and bronchioles, laced together

or isolated, but free in the mucus. One worm was met with in the nasal cavities. The Dog had been troubled for a long time with cough and sneezing.

Strongylus vasorum (Baillet).—In the adult state, this worm lives in the right side of the heart and the larger divisions of the pulmonary artery (see *Hæmatozoa of the Dog*). The ova laid by the female are arrested in the finer arterioles, and there pass through all their phases of development. Their presence gives rise to special granules which are characteristic of this pulmonary Strongylosis, and which were discovered and well studied by Laulanié.

Little is known of the *symptoms* it provokes. Its presence is sometimes betrayed by severe and sudden dyspnœa, which may subside in a few days, or it may terminate in asphyxia. Auscultation and percussion do not furnish any appreciable sign. There is sometimes anæmia, emaciation, fits of dry and feeble coughing, and ascites that disappears after a long rest. The diagnosis may perhaps be assisted by the search for embryos in the mucus or foam ejected during the coughing. Most frequently the affection remains unperceived during life, and is only recognised at the autopsy. It is generally sporadic; though it may become established as an enzoöty in the same pack of Dogs, and make serious ravages.

At the *autopsy* there are found, in the right side of the heart, or in the branches of the pulmonary artery, adult Strongyles. When dealing with the parasites of the circulatory apparatus, we will refer to the characteristics and distribution of these parasites, as well as the alterations they cause in the bloodvessels.

The pulmonary lobes show a well-defined zone at their base, in which the tissue is grey, compact, incompletely retracted, and heavier than water. This is studded with greyish, semi-transparent granules, that rarely attain the size of a pin's head; their accumulation gives a pearly roughened aspect to the free surface and to those of sections, and they become more numerous and confluent as they approach the exterior of the lungs. Beneath the pleura they sometimes form yellow patches which, to the pocket-lens, resolve themselves into distinct granules. Beyond the affected zone these granules are very rare, and they almost completely disappear at the summit of the lungs. This granular zone may consist of only a few sub-pleural islets, or occupy two-thirds of the height of the lung; sometimes the islets are voluminous, and disposed irregularly throughout the periphery of the organ.

In preparations made by teasing out the fresh tissue, there is found—amongst various anatomical elements—a more or less considerable number of elliptical ova, 70 μ to 80 μ long, and 40 μ to 50 μ broad, the shell of which is very thin and often wrinkled, and contains a very granular vitellus, more or less segmented, or already developed into an embryo. There are also a certain number of free living embryos, and when this is the case the bronchi contain masses of them surrounded by mucus.

The granules are the products of nodular vascularities, corresponding to the varieties established by Kiener under the name of 'tubercles of the endogenous type,' and 'tubercles of the exogenous type.' These two types are rarely associated, but when they are, then one of them is in the minority, and appears to be accidental.

The pseudo-follicles of the *endogenous* type may, by their confluence, form nodules varying from ·25 mm. to 1 mm. They are developed in the interior of the smaller arterioles, the epithelium of which proliferates; each comprises: 1. A central zone formed by a giant cell, having a cavity in which is an ovum or embryo; 2. A middle zone, formed by epithelioïd cells; 3. A peripheral zone, composed of embryonal elements arranged in a circular manner.

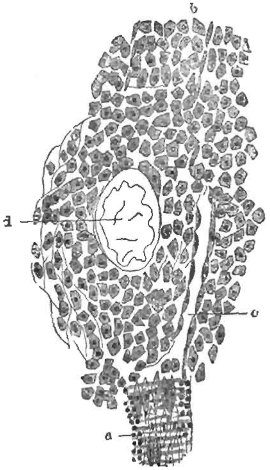

FIG. 315.—Pseudo-follicle undergoing formation on the course of an arteriole *a*, between two layers of muscular fibres, the direction of which is indicated at *b* by a line of epithelial cells; *c*, fissure and epithelial lining insuring continuity in the circulation; *d*, oval cavity.—Laulanié.

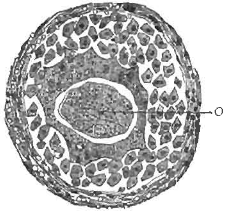

FIG. 316.—Pseudo-follicle in pulmonary strongylosis of the Dog, showing the ovigerous giant cell. The ovum of the *Strongylus vasorum*, *o*, contained in this cell is segmented.—Laulanié.

The pseudo-follicles of the *exogenous* type form smaller and more discrete granules. They are developed in the external tunic of the arterioles and surrounding tissue, and have the same structure as the follicles of the endogenous type, except that the central giant cell rarely acquires such large dimensions, that the embryonal cells accompany the epithelioïd cells of the middle zone, and that the peripheral zone—less limited externally—encroaches on the alveolar walls, sending out buds that project into the alveoli.

Evolution.—Judging by the distribution of the ova and embryos in the granular zone and bronchi, and from a number of experiments with regard to infestation—in which Dogs ate pieces of lungs affected with parasitic granuloma—Laulanié believed he was warranted in arriving at the following conclusions, with respect to the cycle of migrations of the *Strongylus vasorum* :

1. The adult Strongyles fix themselves in the right side of the heart, or the large divisions of the pulmonary artery, couple at these various points, where the females lay their eggs, which are arrested in the finest arterioles, and there undergo all the phases of their development :

2. The hatched embryos leave the inflammatory foci, which have protected them, and wander towards the bronchi, whence they are ejected from the body of the host ;

3. They are accidentally swallowed by Dogs, and in their digestive apparatus or venous system submit to those modifications which bring them to the adult state in the right side of the heart.

'By the light of these facts,' says Laulanié, 'it can be very well understood how strongylosis may assume an enzoötic form, and affect several Dogs in a pack. The attacks—which are marked by much distress and extremely severe dyspnœa—occur from time to time, and apparently coincide with renewed laying of an abundance of eggs by the females—a generation of ova passing into the arterioles, and causing temporary occlusion of these vessels.'

ARTICLE V.—**Helminthiases of the Trachea, Bronchi, and Lungs of the Cat.**

Independently of the *Linguatula denticulatum* which is met with in the lungs of the Cat, other Nematodes have been noticed, either in the adult state or as embryos. These are the *Ollulanus tricuspis, Strongylus pusillus*, and *Trichosomum ærophilum.*

1. **Ollulanus tricuspis** (Leuck).—In the adult state, this worm inhabits the substance of the gastric mucous membrane of the Cat. The embryos laid by the females emigrate in the same manner as Trichina, and the lungs are among the organs they may invade. Each embryo is surrounded by a cyst, in which it remains immovable ; and when the number of these formations is considerable, they give the membrane the appearance of being affected with miliary tubercule, each of them being encircled by a zone of hepatization. The inflammatory process may be so extensive as to cause death. In serious cases, the bronchial mucus is more or less sanguinolent, and contains embryos. (For the history of the development of the Ollulanus, see *Parasites of the Stomach of the Cat.*)

2. **Strongylus pusillus** (Müller).—On several occasions there has been reported a verminous affection of the lungs of the Cat, the macroscopical lesions of which resemble those of tuberculosis in Man ; but it is possible that —as Leuckart remarked—some of these were instances of *Ollulaniasis* (Cobbold). But, with Railliet, we admit that nearly all the cases of pulmonary helminthiasis in the Cat are due to a Strongyle. The simultaneous presence of the ova and the embryo proves, in fact, that both are deposited on the spot. But the worm is very difficult to discover. We once found a non-ovigerous

female, and Railliet has obtained portions of the body of a female. Müller, however, has succeeded in removing entire specimens—male and female—from certain foci; he described them by the name of *Strongylus pusillus*.

The ova and embryos of this Strongyle cause the formation of verminous pneumonia foci, which usually appear as whitish-yellow granules, from the size of a pin's head to that of a hemp-seed, slightly projecting beneath the pleura, or on the surface of a section. Sometimes they are grouped as greyish, semi-transparent nodules the size of a pea, or are imbedded in a somewhat extensive mass of grey hepatization. They often form prominent sinuous streaks.

The pulmonary tissue intermediate to the granules retains its rosy tint and its permeability. By scraping a section of the invaded tissue, a foamy fluid is obtained, in which ova are seen in all degrees of segmentation, and it may contain a well-formed embryo. A large number of embryos move about in this fluid; they are also observed in the mucus of the bronchi, trachea, and upper air-passages—Railliet states that he has seen them likewise in the digestive canal.

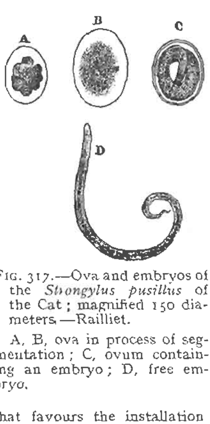

FIG. 317.—Ova and embryos of the *Strongylus pusillus* of the Cat; magnified 150 diameters.—Railliet.

A, B, ova in process of segmentation; C, ovum containing an embryo; D, free embryo.

Laulanié has furnished precise details of the histological lesions of this pulmonary strongylosis.

The ova and embryos are lodged in the pulmonary alveoli. The first are accumulated by hundreds, over a large extent of the field of the microscope—indeed, they are in such compact masses that the network formed by the alveolar walls is broken through, and reduced to thin shreds. They are in all stages and degrees of segmentation and development. They do not produce any other lesion at the points where they are accumulated, than this atrophy by compression of the alveolar walls. On the other hand, the embryos that come from them, by their migration determine a very abundant diapedesis of leucocytes, which fill the pulmonary alveoli, and from this results foci of purulent miliary pneumonia, which, however, have no resemblance to tubercles.

This strongylosis is very frequent; we have remarked it in a fourth of the Cats—19 of 76—we examined. It sometimes coexists with scabies, and the disease of the lungs probably induces a cachetic condition that favours the installation of the psoric malady, or the reverse. In many cases, this verminous pneumonia of the Cat does not reveal itself by any noticeable sign. In some instances, there is frequent cough, coming on in fits, and often followed by vomiting; after a variable time the animal loses condition, its hair is erect, diarrhœa sets in, and the cachexia—which becomes more and more pronounced—brings about a fatal result after an illness of two or three months. Tracheal parasiticide injections constitute the only treatment that can be recommended.

3. **Trichosomum (Eucoleus) ærophilum** (Creplin). This is a filiform worm, the *male* of which is 24 mm. long, and the *female* 32 mm.; the body becomes gradually thicker behind, where it attains 100 μ to 180 μ in diameter, and is attenuated at the posterior extremity. There are two longitudinal bands formed of numerous rods, one of which is ventral, and in width is three-fourths of the total diameter, the other being dorsal and only one-third of this diameter. The tail of the male is truncated, and divided into two lobes, which are united by a thin circular caudal pouch. The sheath of the spicule is covered by very small spines. Eggs ovoid and 72 μ long; they are held on the surface of the female's body by a mucilaginous layer.

This worm was known as a parasite in the trachea of the Fox; A. Müller found it in the lungs of a Marten, and he also met with eight individuals in the trachea of a Cat, affected with strongylosis to a very high degree. We have found three worms of this species in the trachea or larger bronchi of three Cats, two of which were affected with pulmonary strongylosis. These worms were young females, only one of which contained eggs, but they were not yet fully formed.

B.—DOMESTICATED BIRDS.

With the exception of species of Cytodites and Syngamus, the majority of the animal parasites found in the respiratory apparatus of Birds are merely accidental, and only met with at autopsies. The vegetable parasites are represented by *Aspergillus*. We have already said enough with regard to acariasis of the trachea and bronchi, and especially of the air-sacs of the Gallinacei (see p. 216). Syngamus and *Aspergillus* have an importance which requires a special chapter for each. A brief mention will suffice for the other parasites.

Echinococcus gallopavonis (Siebold). A fertile Echinococcus found by Von Siebold, in 1837, in the lungs of a Turkey.

Monastomum mutabile (Zeder).—Body of a dirty-yellow or faint-rose colour, 5 mm. to 24 mm. long, foliaceous; flat beneath, a little convex above; attenuated into a cone anteriorly, broader and rounded behind, where it is 2 mm. to 8 mm. wide. Sucker subterminal, very small, and surrounding the mouth. Ova brown, ovoid, 173 μ long and 84 μ broad; hatched in the uterus, and yielding an embryo that contains a sporocyst. Lives in various parts of the respiratory apparatus of many birds, the majority of which are aquatic. Wiesenthal, Von Siebold, Diesing, and Zürn found it in the sub-orbital sinus of the domesticated Goose; the first of these authorities had witnessed an epizoöty caused by it in 1799 (Diesing). A particular interest attaches to this Monostome, as it was the object of the first observations relative to the development of the Trematodes. Von Siebold showed, in 1835, that the foreign body contained in the embryo survived it in the form of a sporocyst, from which Cercariæ were derived.

CHAPTER I

VERMINOUS TRACHEO-BRONCHITIS (SYNGAMOSIS)

THE Nematodes which live in the air-passages of Poultry, and give rise to symptoms of tracheo-bronchitis, almost exclusively belong to the genus *Syngamus*, of the tribe *Sclerostominæ*, in the family of *Strongylidæ* (see p. 279).

Genus **Syngamus** (Sieb.).—Head thick; mouth large, and succeeded by a chitinous capsule that keeps it open. *Males* relatively small, and provided with two spicules. *Females* furnished with a double ovary; vulva situated in the anterior part of the body. Copulation—which is permanent in the principal species—is effected at an acute angle, and in such a manner that two individuals so united might be taken for a worm with two heads.

Two species have been described in domesticated Birds.

1. **Syngamus trachealis** (Siebold, *S. primitivus* Molin).—A cylindroïd worm, coloured red by the fluid between its organs. Head broad and truncated. Mouth orbicular, and sustained by a hemispherical capsule, at the bottom of which are six or seven sharp lanceolated, chitinous eminences arranged around the œsophageal opening, the margin of which is thick and everted, and cut into six festoons divided symmetrically into four lips. *Male* 2 mm. to 6 mm. long; caudal pouch obliquely truncated, suspended by about twelve ribs and attached around the vulva. *Female* 5 mm. to 20 mm., thin in front, irregularly dilated when it is full of eggs; vulva salient towards the anterior fourth or fifth of the body. Ova ellipsoïd, operculated, 85 μ long and 50 μ broad. A remarkable feature of this species is the permanence of copulation, which is so intimate that the males cannot be separated from the females without tearing their integuments.

This worm—which is known to Pheasant-keepers as the *red worm* or *forked worm*—lives in the trachea and large bronchi of a large number of the domesticated Birds—common Pheasant, golden Pheasant, Fowl, Turkey, Peacock; and of wild Birds—grey Partridge, Magpie, hooded Crow, Chocard of the Alps, green Woodpecker, Sparrow, Martin. It is most frequent in the Gallinacei, and especially in Pheasants.

HISTORY.—The disease caused by the *Syngamus trachealis* was reported for the first time in 1799, by Wiesenthal, who observed it at Baltimore, America, in Fowls and Turkeys. Montagu in 1806, 1807, 1808, saw it prevail as an epizoötic among Pullets, Pheasants, and Partridges in England, into which the parasite had probably been imported from America. Since that date, it has been many times observed in America, England, France, Germany, and Italy. Bellingham and Railliet have noticed it in the Peacock. It is scarcely more than twenty years since it began to figure in French publications. Our knowledge of the development of the Syngamus is due to Leuckart, Ehlers, Mégnin, and Walker.

Symptoms. — Birds attacked by Syngamosis are recognised by 'a kind of sudden, whistling cough, something like a sneeze, which more or less affects young individuals. Those most seriously affected yawn and open the beak, at the same time stretching the neck by a peculiar movement, indicative of the inconvenience they experience. The worst cases have the mouth filled with foamy saliva, which they cannot get rid of' (Mégnin).

The name 'gapes' given to this disease in England and America, indicates the principal symptom. The general signs consist of a diminution of appetite, dulness, feathers erect, and all the characters of a cachexia, which, if asphyxia does not intervene, will terminate in death. According to Renne, there is subcutaneous emphysema of the neck and breast. A German breeder says that, in order to confirm the diagnosis, it is only necessary to hold up a sick Bird — with its neck extended — in the sunlight; the parasite can then be seen through the skin and trachea.

A spontaneous recovery is exceptional, especially in young Birds. A gentleman in Somersetshire wrote to Youatt, stating that Pullets would resist the disease when the feathers of the head and neck began to grow.

This parasite may be the cause of deadly epizoöties. Wiesenthal estimated the losses at four-fifths of the Gallinæ in the invaded localities; Crisp placed at half a million the number of Pullets destroyed by it in England every year: while Mégnin alleges that, in a pheasantry at Rambouillet, there were about 1,200 victims daily.

Fig. 318. — *Syngamus trachealis*; natural size, and magnified 10 diameters. — Railliet.

Lesions.—At the autopsy of Gallinæ which have succumbed to this affection, the parasites are found throughout the trachea—chiefly near its division into bronchi, sometimes at their origin; they are enveloped in foamy mucus. The majority of the parasites adhere so firmly by their buccal capsule, that they will allow themselves to be torn rather than relax their hold; the point to which they are fixed is often formed into a small tumour full of yellow caseous pus. This abscess may become so developed as to obstruct the trachea, and one alone may induce asphyxia. The number of couples found in one Bird is variable; but two or three may kill a Pheasant of four to six weeks old, though it requires twenty-five to thirty to asphyxiate an adult Pheasant. Independently of the power of resistance conferred by age, the differences in other respects may be related to the diameter of the trachea (Mégnin).

Etiology.—The disease scarcely attacks any but young Birds, and then more especially during certain years, though there is nothing certain to account for this. Some poultry-breeders declare that the fattest and best conditioned Birds are the first attacked.

The ova of the Syngamus are developed to a variable degree in the uterus of the female, according to its age and size; when it is 20 mm. to 22 mm. long, the embryo is completely formed (Cobbold, Mégnin). These ova are not laid, and they can only escape from the body of the female in case of rupture, which, in ordinary circumstances, results from cadaveric decomposition. The ova—whether embryonated or not—fall on damp ground or in pools of water, and are hatched in from seven to forty days, according to the temperature. Ehlers has shown that the embryo has no need of an intermediate host, in order to become transformed into an adult worm. In Birds which he had caused to ingest ova containing embryos, in about twelve days he found coupled individuals, and—after seventeen days—females full of eggs. Walker has observed that the embryos remain alive in the digestive canal of the earth-worms, and that when Birds swallow these they become affected with Syngamosis. Mégnin has given the 'gapes' to a Parrot, by feeding it with a certain number of the worms collected from Pheasants. It has been noted that affected birds often cough up the parasites, and their companions immediately swallow them with avidity. This is evidently the way in which Syngamosis is propagated.

The way in which the embryos reach the respiratory apparatus is not known. Perhaps they become adherent in the pharynx during deglutition, and afterwards pass directly into the trachea.

Treatment.—Isolate the affected Birds, and put those yet healthy on clean ground. Bury deeply or burn the bodies of dead Birds; disinfect the ground of the pheasantry or poultry-yard, by sprinkling over it a 1 per thousand solution of salicylic or sulphuric acid; give uncontaminated food and water to the Birds, adding to the water 1·3 grammes of salicylate of soda to the litre—such are the preventive measures recommended by Mégnin.

In America and also in England a feather from which all the barbules have been removed except those at the point, is introduced into the trachea and turned round there, with the object of detaching the worms; but this is an insufficient and dangerous proceeding, and can only remove a small number of the parasites which are situated at the upper parts of the trachea, and are exceptionally slightly attached to the mucous membrane; while it may cause suffocation or even sudden death.

Garlic has been employed with much success, first by Montagu, then by Mégnin. Montagu gave an infusion of rue and garlic, instead of water, to drink. Mégnin prescribed, as food, a mixture of hard-boiled eggs, ox-heart soup, stale bread, aud salad, all well mixed up with chopped garlic, added in the proportion of one clove of the latter daily to every six Pheasants. He was also fortunate in the employment of powdered asafœtida with an equal part of powdered gentian, these being incorporated in a cake, and given in the proportion of ·50 gramme per head every day. He also added to every litre of drinking water, a solution of 1 gramme of salicylic acid in 100 grammes of water.

It is in being eliminated by the air passages, that the volatile principles of garlic and asafœtida act as toxicants on the red worms of the trachea.

Mégnin recommends, besides, fumigation with sulphurous acid; the fits of coughing to which it gives rise cause the expulsion of the parasites. But this means requires much watchfulness, in order to avert accidents from suffocation.

The breeder above-mentioned, advises the employment of an 8 or 10 per cent. solution of salicylic acid, a few drops of which are to be carefully injected into the trachea by means of a straw. And 'an English farmer says he has rarely lost an affected individual since he resorted to tobacco smoke. He places the pullets in a box, which he covers with a cloth; then puts a little tobacco in a pipe, lights it, puts some more tobacco on the top, introduces the pipe into the box and blows gently through the stem, until the Birds fall over almost inanimate. He then restores them to the open air, when they soon recover their health' (Railliet).

Those who have employed it speak highly of paraffin, applied directly to the upper part of the trachea by means of the tip of a feather. Tracheal injections do not yet appear to have been seriously tried.

2. **Syngamus bronchialis** (Mühlig).—Body cylindrical, and tapering slightly in front. Mouth arranged as in *S. trachealis*. *Male*, 10 mm. long; caudal pouch spherical, entire, and sustained by ribs, the two posterior of which are tridigitated, and arise from a common trunk that is nearly double their length, the middle and anterior ones cleft—the external anterior lying alongside the middle one; spicules filiform, curved at the end, and fringed at the inner margin. *Female*, 25 mm. long, the posterior extremity terminating in a conical point; vulva slightly salient, and situated at the first third of the length of the body. Ova ellipsoïd, non-operculated, and 90 μ long by 60 μ broad. Copulation is not constant, and the coupled worms may be disengaged without tearing the integuments.

This worm has been found by Mühlig in some young Japanese Geese. It is at least closely related to the species which lives in the black Stork, and which Diesing named *Sclerostomum tracheale*—the *Syngamus Sclerostomum* of Molin.

Mühlig met with this Syngamus to the number of 20 to 30, forming bundles in the larynx, trachea, and bronchi, the ultimate ramifications of which they had reached, and where they were enveloped in a thick mucus. There was sometimes a croupal pneumonia, and an exudate of the same character was thrown out into the air-sacs, which also contained ova that had undergone segmentation to a variable degree, and free embryos. The symptoms were analogous to those noted in the Gallinæ, and consisted chiefly in gaping and a characteristic cough.

Przibylka has several times observed the same affection in Geese. It attacked, by preference, the young ones, and always terminated in death. Besides the above symptoms, he remarked a state of debility that kept the Birds lying for a long time, accompanied with convulsive movements of the head, and efforts to vomit—due to the mucus, mixed with worms, that had accumulated in the trachea and bronchi.

Hayem found in each of two Ducks—which were at the same time affected with pulmonary mycosis—twenty worms agglomerated in bundles in the trachea, and particularly in the syrinx; some had even penetrated the lungs. Hayem assigned to them a length of 35 mm. to 40 mm. for the *females*, and about 15 mm. for the *males*. He classed them with the *Sclerostomum armatum* Dies. of the Horse—the *Scl. equinum* Müll.; but it is more probable that they belong to another species of *Sclerostomum* or *Syngamus*—perhaps, even, to the *Syngamus bronchialis*.

CHAPTER II

MYCOSIS OF THE AIR-PASSAGES IN BIRDS

A LARGE number of observations have established the fact that the Fungi of moulds—*Mucedinæ*— belonging to the genus *Aspergillus* Micheli, may develop and vegetate in the respiratory apparatus of Birds—exceptionally in Mammals—and cause serious alterations in it. According to the seat they occupy, we have *broncho-mycoses*, *pneumomycoses*, and *cytomycoses* or mycoses of the air-sacs.

Birds.—The first recorded case of pneumomycosis goes back as far as 1815, and is due to Meyer and Emert, who observed it in a Jay. Afterwards, similar occurrences were noted in the Flamingo, Eider-duck, Sea-gull, Stork, Ostrich, Plover, Parrot, Bullfinch, Raven, Owl, Falcon, etc., with regard to wild Birds; and in such domesticated Birds as the Fowl, Pheasant, Pigeon, Goose, Duck, and Swan.

Four species of *Aspergillus*—*Asp. glaucus*, *Asp. nigrescens*, *Asp. fumigatus*, *Asp. Candidus*—have been found in the parasitic state, though this is only accidental for them, as, like the other moulds, they develop almost exclusively on dead organic matters.

Mycoses of the air-passages have been observed in Poultry, by Serrurier and Rousseau in 1841, Bollinger in 1881, and Perroncito in 1883; in Pheasants by Robin in 1848, and Rivolta in 1887; in Pigeons by Serrurier and Rousseau in 1841, Bonizzi in 1876, Generali in 1879, Bollinger and Kitt in 1881; in Geese by Fresenius in 1858, and Schütz in 1884; in Ducks by Hayem in 1873; and in Swans by Jäger in 1810, and Zschokke in 1887.

The *Symptoms* consist at first in an acceleration of the respiration, in a more or less serious catarrh of the trachea and bronchi, and a ronchus heard loudest in expiration. Then the respiration becomes more and more difficult and suffocant, and the ronchus louder and rumbling, as in diphtheria. There is fever, the temperature of the body is elevated, the appetite is diminished or has altogether disappeared, but the thirst is, on the contrary, increased. The sick creatures keep aloof, and are feeble and depressed; the wings droop, the feathers are erect, the eyelids half closed, the head pendulous, and the aspect somnolent. Emaciation sets in more or less rapidly, and a colliquative diarrhœa carries off the Birds in from one to several weeks—or even two months' illness. In mycosis of the air-sacs, marasmus is sometimes the only sign of the malady.

The *Lesions* are seated in the trachea, bronchi and lungs, and various air-sacs—rarely in the nasal cavities, or the air-sinuses of the bones.

They are nodules, or plane or discoid membranous formations, 3 mm. to 10 mm. thick, of a dirty-yellow or greenish colour, and are at first soft, then more consistent, and in the form of a fibrino-purulent exudate. Sometimes the air-cavities are more or less obstructed by these formations, which are then thicker and firmer. They may undergo caseous or calcareous degeneration. In their substance, but more especially on their surface or superficial layers, are found the mycelium and conidian apparatus of an *Aspergillus*. The exudate is composed of fibrin in which are many leucocytes—the majority of these being infiltrated with fat—and multitudes of micrococci. In the lungs are agglomerated or disseminated nodules, these organs presenting the appearance of caseous pneumonia. Perroncito on one occasion found the affection localized in the membrane lining the thoracic sacs and the peritoneum, the lesions consisting of nodules, the largest of which were the size of a pin's head, and in their centre was a mycelium of the *Aspergillus*.

It is possible that, in some cases, the Fungi establish themselves only in respiratory organs already enfeebled by some disease ; but generally they are veritably and primarily pathogenic. Spores from forage and litter penetrate with the inspired air, and find in the mucous membrane of the respiratory passages a warm, moist medium that is favourable to them ; there they throw out a mycelium which, in developing, gives rise to inflammatory phenomena. This conclusion results from the interesting researches of Schütz. Siebenmann had shown that the *Asp. fumigatus* and *Asp. nigrescens* vegetate at a somewhat high temperature ; and Schütz has recognised that the first of these species—which requires a temperature of 37° to 40° Cent., is the most dangerous ; while *Asp. nigrescens*—which grows at 35° only—is less to be feared, for *if its spores germinate at the temperature of the body of Birds, it will not produce a true mycelium.* With regard to the *Asp. glaucus*, it does not germinate at the animal temperature, and, according to Schütz, its spores can only act as a foreign body by mechanical irritation and obstruction of the air-passages.

The finer and more delicate breeds of Pigeons are, according to Generali, more exposed than the common breeds to the pneumomycoses and mycoses of the air-sacs.

The prophylaxis of this affection—which may appear in an epizoötic form—evidently consists in rigorous cleanliness of the fowl-roosts and dove-cots, etc., in their disinfection with boiling water, and in the destruction of everything invaded by the moulds.

The malady is usually fatal. At its commencement, however, benefit may be derived from the employment of tar vapour, engendered as follows : a spoonful of vegetable tar is poured on a pint of water, and this is then stirred about with a piece of red-hot iron ; but the vapour should not be so dense as to be irritating.

BOOK V

PARASITES OF THE CIRCULATORY APPARATUS

Among the embryos of parasites which, when introduced into the digestive apparatus, do not find there the conditions required for their development, a large number pass through the gastric or intestinal wall in search of a habitat better adapted to their needs. Some of them in these migrations enter the bloodvessels, and in them are passively carried on to the place where they will undergo their ulterior development—such are, as an incontestable example, the parasitic Helminthes of the nerve centres. The blood from various parts of the body, in this way often acts as a carrier of the parasites, which, owing to their microscopical dimensions, and their extensibility, can pass through the capillary networks. The majority only pass through the circulation, but there are some which make the blood their habitat—it attracts and retains them; these, for this reason, are named *Hæmatozoa*, because one of the phases of their existence requires the blood as a medium.

The majority of Hæmatozoa are Helminthes, though Protozoa have been observed in the blood of several Mammals and domesticated Birds.

Independently of the Hæmatozoa, other Helminthes—in developing in the myocardium—are capable of determining grave alterations. If the heart could admit all the parasites which have the muscles for their habitat, the Echinococci would alone deserve to be examined here, as they of themselves are a source of danger. They may be met with in the heart of all the animals which harbour them, but their evil effects have only been noted in the Ox and Horse.

In the following chapters we will examine the various larger parasites which have been found in the circulatory apparatus of the domesticated animals.

CHAPTER I

HÆMATOZOA OF THE HORSE

THE parasites of the blood or of the organs of circulation in the Horse, are the *Piroplasma equi*, the Trypanosomes of Dourine (*Trypanosoma equiperdum*), Surra (*T. Evansi*), Mal de Caderas (*T. equinum*), and Nagana or Tsetse Fly disease (*T. Brucei*) ; and Nematodes in the embryonic or larval state. Echinococci are sometimes also found in the walls of the heart or arteries ; but only the parasitic Nematodes of the circulatory apparatus will be dealt with here.

Nematodes.

The Nematode most frequently met with in the circulatory apparatus of the Horse, is the armed Sclerostome. Sometimes embryos are observed, which may belong to a recognised adult form.

Embryos of Nematodes.—Sonsino has given the name of *Filaria sanguinis equi* to microscopical larvæ discovered in the blood of a Horse in Egypt. They were similar to those of the *Filaria sanguinis hominis*, which is found in Man in the hot parts of Asia and America ; but they were smaller, those of Man measuring 120 μ to 125 μ long, and 8 μ to 11 μ broad. It must be remarked that at the autopsy of the Horse in question, a number of the *Filaria papillosa* were found in the peritoneal cavity, and these may have been the source of the Hæmatozoa ; for Wedl had observed embryos in the blood of a Horse, in the peritoneum of which was a *Filaria papillosa*.

Lange, of Kazan, reports that Jakimoff found in the blood from various parts of the body of a Horse affected with hæmaturia, the embryos of Nematodes in such quantities that each drop of blood contained one or two. They were about 30 μ long and 5·4 μ broad. None were met with in the urine of this Horse, which recovered rapidly. Lange was inclined to consider these Nematodes as the cause of hæmaturia, chiefly in an enzoötic form, and he likens their effects to those produced by the *Filaria sanguinis hominis*.

Mazzanti found at Pisa, in the hepatic vessels of a Horse, the embryos of Nematodes from 10 μ to 180 μ, and 2·85 μ to 5·7 μ, with a tail sometimes obtuse, sometimes acuminated. They were different from those of the *Filaria papillosa*, and Mazzanti regarded them as the cause of the nodules that are at times observed in the hepatic parenchyma.

Sclerostomum equinum (*Strongylus armatus* Rud.).—This parasite, in the adult state, inhabits the cæcum and commencement of the large colon, but it is often met with in the arteries of the Horse, Ass and Mule, and generally causes the formation of aneurisms.

A knowledge of parasitic aneurisms goes back to the seventeenth century. In 1665, Ruysch discovered in an aneurism of the mesenteric artery of a Horse an innumerable quantity of small worms, and later he published three or four similar observations. In 1725, Schultze recorded another instance; as did Chabert in 1782, he quite naturally calling these worms *crinons*. Since then such observations have been greatly multiplied, principally by Ruldophi, Hodgson, Greve, Rigot, Trousseau, and Leblanc, and Hering. Rayer, and more especially Bollinger, have made an attentive study of this parasitism, and have definitively established its essential points.

FREQUENCY OF THE ANEURISMS.—These verminous aneurisms have only been seen in the Equidæ—Horse, Ass, Mule, and Hemione (Laboulbène).

According to Numan, they are more frequent in the Ass than in the Horse. Hering asserted that, except in young Foals, it is rare to find a Horse without aneurismal dilatation; and Bollinger estimated at 90 to 94 per cent. the proportion of adult Horses so affected. According to Semmer, at Dorpat all the Foals, without exception, have verminous aneurisms. Mather has witnessed a kind of epizoöty break out among Foals, consisting of verminous aneurisms of the aorta, near the origin of the renal arteries.

SEAT.—These aneurisms are only seen on certain visceral branches of the posterior aorta, and exceptionally on the posterior aorta itself. In 65 Horses, Hering has noted aneurism of the trunk of the great mesenteric artery in 7 cases; the cœliac artery in 59 cases; the cæcal artery in 18 cases; the artery of the small intestine in 16 cases; the small mesenteric artery in 2 cases; the cœliac trunk in 2 cases: the hepatic artery in 3 cases; and in the renal artery in 1 case. It is not uncommon to find more than one aneurism in the same Horse.

In 35 Horses, Bollinger counted 60 aneurisms; and in adding these to the 108 seen by Hering in 65 Horses, he reckoned that in 100 Horses there were 168 aneurisms, of which 153 were in the large mesenteric artery and its branches, 4 in the cœliac trunk, 3 in the hepatic artery, 3 in the small mesenteric artery, 3 in the renal arteries, and 2 in the posterior aorta. In 100 Horses, 90 to 94 had one or more verminous aneurisms. Sclerostomes were also several times found in the spermatic artery, and on three occasions in the cerebral arteries (see *Parasites of the Genital Organs, and Parasites of the Nerve Centres*). Lastly, Röll indicates them as being found in the vena cava, and, according to Valentine, a specimen was discovered in the vena portæ, at the Berne veterinary school.

PATHOLOGICAL ANATOMY.—The verminous aneurism is usually fusiform, sometimes globular or cylindroïd. Its average size is about that of a walnut; though it may not exceed that of a pea, or it may attain the dimensions of a Man's head.

It consists of a dilatation of the affected artery, with hypertrophy of its walls. The dilatation is sometimes absent, notwithstanding grave thrombic lesions in the vessel (Durieux).

The *external tunic* is usually thickened, and variably indurated,

according to the age of the tumour. It adheres firmly to the neighbouring parts, and is more or less confounded with the surrounding connective tissue.

The *middle tunic* is always hypertrophied, and sometimes very much so. Its thickness—which is ordinarily about a millimètre—may attain, and even exceed, two centimètres. At one time this thickening is due to simple hypertrophy of the tunic; at another time it is owing to inflammatory phenomena, with atrophy of the muscular fibres.

The *internal tunic* is nearly always altered. It may present every degree of endarteritis, and of regressive metamorphosis—from partial thickening, and a white milky tint, to ulceration,

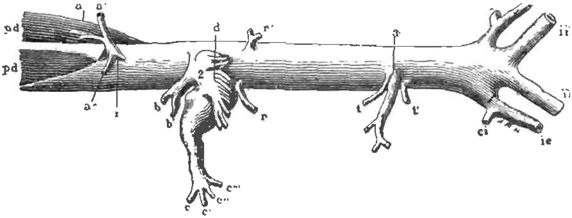

FIG. 519.—Abdominal Aorta of a Horse, with its Ramifications.

1. Cœliac trunk: *a*, gastric artery; *a'*, splenic artery; *a''*, hepatic artery.—2. Trunk of the great mesenteric artery, slightly aneurismal: *g*, left colic artery; *b'*, first artery of the floating colon; *c*, right colic artery; *c'*, inferior cæcal artery; *c''*, superior cæcal artery; *c'''*, ileo-cæcal artery; *d*, arteries of the small intestine; *r*, right renal artery; *r'*, left renal artery.—3. Trunk of the small mesenteric artery: *t*, *t'*, right and left spermatic arteries; *ii*, internal iliac arteries; *ie*, external iliac arteries; *ci*, circumflex iliac arteries; *pd*, crura of the diaphragm.

atheromatous transformation, and calcification; the latter, however, is always rare, and may exceptionally assume an aspect of real ossification.

In the interior of the aneurism there is usually a fibrinous deposit—a thrombus—always adhering, though to a variable degree, to the internal membrane. It is more or less regular and consistent, and partially blocks the vessel; but there is always a canal in the middle for the passage of blood. This thrombus is often prolonged in the artery beyond the aneurism, both before and behind; and its external layers are capable of becoming organized and undergoing softening. Its formation is essentially connected with the presence of the worms, the inflammatory processes—ulcerative and regressive—in the internal tunic, and the dilatation of the vessel. Decroly has published a remarkable case, in which the alteration in the aorta extended from the heart to the lumbar region.

In the aneurism, worms are found in nine cases out of ten; their average number is from 9 to 11, and varies between 2 and 121. When they are absent, the lesions have a chronic character; but when they are present, then these are more or less acute. The

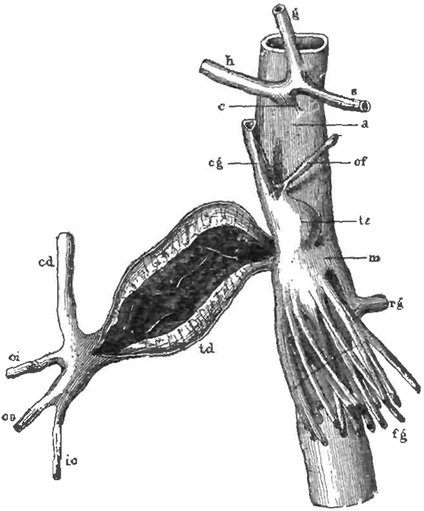

FIG. 320.—Verminous aneurism of the great Mesenteric Artery; one half the natural size.—Railliet.

a, aorta; *c*, cœliac trunk; *h*, hepatic artery; *g*, gastric artery; *s*, splenic artery; *m*, trunk of the great mesenteric artery; *ta*, trunk of the anterior fasciculus, the seat of a small aneurism; *cg*, left colic artery; *cf*, first artery of the floating colon; *fg*, arteries of the left fasciculus or small intestine; *td*, trunk of the right fasciculus, the seat of an aneurism: the upper wall of the vessel has been excised, to show the thickening of the middle coat of the artery, the internal clots, and the sclerostomes fixed therein; *cd*, right or straight colic artery; *ci*, inferior cæcal artery; *cs*, superior cæcal artery; *ic*, ileo-cæcal artery; *rg*, left renal artery.

parasites are young armed Sclerostomes. They are rose-tinted, and their average length is from 1 to 3 cm.; their sexual characters are already well defined, but their genital organs remain rudimentary. They undergo one moulting in this situation, in which their buccal armature assumes its definitive characters. Some

are almost free in the cavity of the artery; but the majority are more or less concealed in the layers of the thrombus—the head or tail usually projecting into the blood-stream. They are also found in the hypertrophied walls of the artery, in either the internal or middle coats, or between these two. Sometimes nothing is found of them except the integuments they left after their final moulting. Generali found in an Ass—besides the aneurism of the mesenteric artery—a tumour situated at the origin of the arteries of the small intestine, which had two abscesses in its interior, each of which contained a male Strongyle.

The gravity of verminous aneurism is due to the risk of rupture of the vessel, and more especially—as Bollinger has pointed out—to its influence on the frequency and seriousness of colics.

The clot formed in aneurism of the great mesenteric, or other artery, may throw off one or more fragments, which are carried by the blood, and constitute so many emboli in the arterial ramifications passing into the intestine. According to the size of the embolus, the obliterated artery is itself more or less voluminous, and the disturbance set up more or less serious; there is sudden anæmia or ischæmia of that portion of the intestine to which the artery is distributed, and consequently paralysis of one or more of the sections of the digestive tube, the secretions and movements of which are suspended. Cohn and Panum have shown experimentally, in fact, that such are the results of embolism of the great mesenteric artery. The ischæmic portion of the intestine becomes at first pale, then of a dark-red colour; the mucous membrane is swollen, there are hæmorrhagic infarcts, serous exudates, ecchymoses, and sometimes a considerable increase in the volume of the organ.

The circulation disturbances of the intestine cause a local paralysis, with stagnation and consequent fermentation of its contents, and an abundant production of gas. The enteralgia induced in the healthy portions causes energetic contractions, which frequently lead to volvulus and invagination. Friedberger and Fröhner have often observed the rotation on its axis of the left part of the large colon—that is, its free portion—which is, of all the intestinal divisions, the most liable to thrombosis and embolism. Paralysis of the intestine often brings about rupture of it, the stomach, or the diaphragm, owing to fermentation and enormous accumulation of matter and gas. At the autopsy of Horses which have died from colic, it is often difficult to discover the obstructed artery and the seat of the embolus, because of the great development of the intestinal vessels, and more especially on account of their congested condition; so that much care and patience are needed in this search.

The effects of the aneurism—the thrombosis, and the embolism—are evidently subordinate to their situation. The presence alone of the aneurism and its clot reduces the calibre of the great mesenteric artery, and consequently diminishes the supply of blood to the

intestine ; this is sufficient to explain the chronic indigestion troubles observed, and these effects are all the more marked if the diminution in the lumen is extended to a ramification, but they are especially so if the vessel becomes completely obstructed by a detached fragment of the thrombus. But as the arteries of the small intestine anastomose freely by inosculation close to the concave curvature of the organ, embolism of one of the vessels is never a fatal accident. It is the same with obliteration of one of the two cæcal arteries ; for the other which anastomoses with it near the point of the cæcum can assume its function, so that the attacks of colic pass off. But if the trunk of the right fasciculus of the great mesenteric artery is completely obstructed, the cæcum does not receive any blood, and death quickly ensues. The large colon receives its blood by the two colic arteries, which have an independent origin ; so that it seldom happens that both are blocked at the same time.

The floating colon would be exempt from the danger of aneurismal embolism but for its first artery, which is derived from the great mesenteric ; the other arteries arise from the small mesenteric, in which aneurism is rare.

In cases of death from aneurism, the alterations described above are most frequently found. There may also be rupture of a verminous aneurism, and abdominal hæmorrhage. But, as Friedberger and Fröhner have remarked, embolic colic may terminate in death in twelve to twenty-four hours, and before serious intestinal alterations have had time to occur. The intestine is in such cases usually very distended by gas, and obstructed ; and death is then due to one of the following mechanical causes :

1. Asphyxia and œdema of the lungs, as a consequence of severe and prolonged compression on the diaphragm. 2. Cerebral or pulmonary apoplexy, due to the increased arterial tension from the pressure of the distended abdominal viscera on the larger arteries. 3. Carbonic acid intoxication, by diffusion of that gas from the digestive organs into the blood. 4. Intoxication by septic products or infection from particulate elements, derived from the necrosed intestine, and accumulated more particularly in the liver, which is found immediately after death in a state of advanced decomposition. 5. Cardiac syncope, induced by the violence of the intestinal pain, or resulting from the poisoning by phenol, which is produced in large quantity in the course of the abnormal intestinal fermentation. Tereg, however, estimates that in colic the production of phenol is rather diminished than increased.

Symptoms, Course.—Verminous aneurism rarely gives rise to characteristic symptoms, and its presence is often only recognised when rupture has taken place, which rapidly terminates in death from internal hæmorrhage. On the occurrence of this accident—which coincides ordinarily with a severe effort—the animal crouches or sits on its hind-quarters, knuckles over at the fetlock-joints, and falls as if struck with paraplegia ; the pulse is thready, limbs

cold, visible mucous membranes blanched, etc.; and, generally, the last moments of life are marked by signs of profound and violent suffering. Aneurism of the aorta appears to be more liable to rupture than that of the great mesenteric artery. As a rule, the blood flows into the peritoneal cavity, but sometimes rupture takes place directly into the intestinal canal. In 18 cases collected by Bollinger, 15 were of rupture into the abdominal cavity, and 3 into the intestine. The latter result might be recognised sometimes from the presence of blood in the fæces passed before death.

Rupture of verminous aneurism is attributable to the feeble resistance of its walls—which have lost their elasticity and contractility—and to the increased arterial pressure, resulting from diminution in the lumen of the vessel.

Besides the cases of rapid death, there have been noted—as symptoms of aneurism of the posterior aorta—decrease in vigour of the animal, stiffness in movement of the hind-quarters, difficulty and pain in micturition, arching of the loins, infiltration and intermittent lameness of one or both hind-limbs, cramps, and signs of paraplegia; but these indications are not sufficiently characteristic to afford a sure diagnosis, though they may arouse suspicions, which will sometimes be confirmed by a rectal exploration.

In some cases the embolic obstruction of the small arteries of the intestine—when often repeated—ends in hæmorrhagic enteritis, to which the animal succumbs in several days or weeks. Friedberger and Fröhner attribute to this state the following symptoms: Diminution of appetite or complete inappetence, increased thirst, and rare defecation; the fæcal pellets are small and dry at first, then become soft, pasty, and, later, sanguinolent and fœtid; the urine is acid, and rich in phosphates; the fever is intense and persistent, and the pulse small and quick; the general debility increases, the animal becomes emaciated and the abdomen retracted; and now and again there is coma. Frequently, after feeding there is general aggravation of the symptoms and colic. Death is often ushered in by febrile paroxysms, muscular tremors, shivering, coldness of the limbs, pallor of the mucous membranes, quickened, difficult, and rattling respiration, tumultuous beating of the heart, and considerable elevation of the rectal temperature.

To sum up, colics which have their origin in disturbance of the circulation, have no particular signs which would allow them to be distinguished with sufficient precision in the complex group of abdominal complaints.

TREATMENT.—It is of the highest importance, from the above considerations, to diminish the extension of the Sclerostomes as much as possible. This can only be done by a most careful inspection of the water Horses drink, and filtration alone affords reliable security. But the danger of the aneurismal worms is not sufficiently tangible—at least, to owners of Horses—to permit of the hope that a precaution which would be so disturbing to current usages is likely to be adopted.

With regard to treatment, this can only be brought to bear on the principal symptoms. The stasis of intestinal matters should be combated by the employment of saline purgatives or calomel; drastic purgatives—such as tartar emetic and aloes with anodynes—are prescribed to avert irritation and violent contractions of the intestines. A good *régime*, frictions, exercise, enemas, or frequent manual evacuation of the rectum, are particularly indicated.

In the case of Horses subject to colic, or which manifest rigidity or exceptional sensibility in the lumbar region, the prolonged but carefully observed use of oil of turpentine might have a good effect; for it is not inadmissible that this medicament may act efficaciously against the worms contained in the aneurisms to which they have given rise.

Observation.—We need only mention here the *Spiroptera reticulata* Creplin, which has been found sometimes in the collateral artery of the cannon and in the arteries adjoining the cervical ligament. As it is more particularly met with in the ligaments, it will be most appropriately considered when noticing the parasites of the muscles and connective tissue.

CHAPTER II

HÆMATOZOA OF RUMINANTS

ONLY two observations with regard to Nematodes in the blood of Ruminants have been recorded, and both have reference to the Camel. Goubaux mentions having found in this animal numerous 'Filariæ' in a lachrymal gland, in the lungs, in the blood, and in the lymphatic vessels. Evans has also discovered in the blood of a Camel a Filaria, which Lewis has described under the name of *Filaria Evansi*.

It was no doubt by an error that Schneider quoted Gurlt as having found in an arterial aneurism of the Cow the *Strongylus micrurus*, which has the bronchi of Bovines for its normal *habitat*.

Excepting the Piroplasmata of Texas Fever, or Red-water (*P. bigeminum*) and Rhodesian Fever (*P. parvum*), the only important Hæmatozoon of Ruminants is the *Bilharzia crassa*; though mention should also be made of the Cystic worms that may be seen in the walls of the aorta, or in those of the heart, which may also harbour in its tissue the various muscle parasites.

Bilharzia crassa Sons.—The name of *Bilharzia hæmatobia* (*Distomum hæmatobium* Leuckart) was given by Cobbold to a worm discovered in 1851 by Bilharz, at Cairo, in the portal vein of Man. It has since been frequently found throughout the whole extent of the East African coast, in Arabia, the Mauritius, and in India; it more especially abounds in the vessels of the portal system and mesentery, and in the hæmorrhoidal and vesical veins. The ova are carried into the bladder or intestines, and there occasion hæmaturia or enteritis. An analogous worm was also found in 1876, at Zagazig, Egypt, by Sonsino, in the portal vein of a Bull, and subsequently in the Sheep. He named it the *Bilharzia bovis*, a name which he rightly changed afterwards to that of *Bilharzia crassa*.

The *Bilharzia crassa* is a Trematode, of the family of *Distomidæ*, which offers the remarkable peculiarity of separate sexes. The *male* is whitish, cylindroïd, and possesses an oral and a buccal sucker quite close to each other. It carries the female in a ventral furrow—the gynæcophoric canal—formed by the two sides of the body, which are broad and reflected inwards. The *female* is filiform, longer, and much narrower than the male; its middle portion only is contained in the gynæcophoric canal, its anterior and posterior portions remaining free. The genital apertures of the two individuals correspond—they are situated immediately behind the ventral sucker.

This species (*crassa*) is a little longer and sensibly thicker than the *B. hæmatobia*, the length of which is about 14 mm. in the male and 20 mm. in the female. A more important difference is to be found in the form of the ova, which in *B. crassa* are ·16 mm. to ·18 mm., are longer, narrower, and fusiform, and are also prolonged at one of their poles by a pyriform point. These ova contain a ciliated embryo, which is set free in water, and shows traces of a digestive apparatus.

The *B. crassa* causes, in animals, similar disorders to those which the

B. hæmatobia engenders in Man. In an Ox, the blood of which furnished thirty of these parasites, Sonsino observed very pronounced intestinal catarrh, with thickening, exudation, and ecchymoses in the walls of that tube. The vesical mucous membrane was ecchymosed and covered with papilliform elevations, which were yellow at the point, and about the size of a pin's head. The vessels contained the ova of *Bilharzia*. It is possible that the hæmaturia which so frequently affects Cattle in East Africa and the Cape of Good Hope is due to this parasite. Like Man, they derive the germs of the disease from the impure water they drink.

At the autopsy of Oxen which were killed at Calcutta, suspected of being affected with cattle-plague, Bomford found in the substance of the mucous membrane or in the papillary excrescences at the margin of the anus, ova of the *Bilharzia*, which, from their characters, belonged rather to the *B. hæmatobia* than to *B. crassa*. If these Cattle had never been in Africa—as this authority states—we might conclude that the *Bilharzia* also lives in India.

On the other hand, Grassi and Rovelli have announced that 75 per cent. of the Cattle slaughtered at Catania are infested with the *Bilharzia crassa*. If this is really so, these Ruminants would be dangerous for Mankind, as we must look upon *B. crassa* as merely a variety of *B. hæmatobia*.

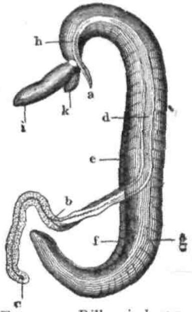

FIG. 321.—*Bilharzia hæmatobia*, male and female; highly magnified.—After Bilharz.

abc, female partly contained in the gynæcophoric canal: *a*, anterior extremity; *c*, posterior extremity; *d*, body seen through the wall of the canal; *ig*, male; *ef*, gynæcophoric canal half opened in front, and behind is the female, which has been partly extracted; *g*, *h*, limit towards the back of the ventral depression which constitutes the canal; *i*, buccal sucker; *k*, ventral sucker.

Hydatids of the Circulatory System.—We will hereafter, with regard to *Measles*, notice the presence of *Cysticerci*—*Cysticercus cellulosæ* and *C. bovis*—in the muscular tissue of the heart. In the meantime it may be observed that, according to Davaine, Bremser has on two occasions seen the *C. tenuicollis* in the walls of the Ox's heart. The parasites with which we have now chiefly to deal are the *Echinococci*.

These Echinococci are more particularly observed in the heart of the Ox; nevertheless, Bollinger records two cases of Echinococci in the *Horse*—one of these being in the walls of the common aorta near its bifurcation, the other in the posterior aorta. Palat has seen a Horse die suddenly from compression of the aorta, caused by a hydatid situated at the base of the left ventricle; the cyst contained only a simple vesicle. Goubaux has also witnessed the sudden death of a Horse, from rupture of the aorta at its origin; the walls of the vessel contained three small acephalocysts.

Hydatids in the substance of the heart of the *Ox* have been observed several times in Germany, England, Italy, and France. Alix has found six or seven specimens in Tunisian Oxen killed in the abattoir of Sfax.

These cysts remain unperceived during the life of their host, and only attract attention when they cause death by rupture of the walls of the heart, or by compression of vessels and obstructed circulation. Generally there is only one Echinococcus cyst; but the number may occasionally rise to twenty (Morot). Their volume varies between that of a millet-seed and a Turkey's egg. They may occupy various points, either on the external surface of the organ or near its inner surface, or in the ventricular septum, near the base or point of the heart, and more frequently in the walls of the ventricles than in those of the auricles.

Generally the vesicle is simple—that is, it has no secondary vesicles, external or internal; and it rarely appears as an acephalocyst—or sterile. It may undergo caseous or calcareous degeneration. Grimm considered what he found in the ventricular septum of a Cow, to be a multilocular (?) cyst.

No reliable signs have yet been made known by which the presence of these hydatids in the heart may be suspected during life.

CHAPTER III

HÆMATOZOA OF THE DOG

THE Dog is the domesticated animal in which Hæmatozoa are most frequent, and excepting *Piroplasma canis*, these are always Nematodes. They belong to four distinct species: *Filaria immitis* Leidy; *Strongylus vasorum* Baillet, which, in the adult state, lives in the right heart and the pulmonary artery; *Spiroptera sanguinolenta* Rud., which is usually found in tumours of the œsophagus and stomach, but has also been met with in similar tumours in the aorta; *Filaria recondita* Grassi, of which only the embryos—*Hæmatozoa of Lewis*—are known, which float in the blood, and which must not be mistaken for those of the *Filaria immitis*.

ARTICLE I.—Hæmatozoa of Lewis.

Grassi gave the name of **Hæmatozoa of Lewis** (*Hæmatozoon Lewisi*) to embryonic Nematodes, which several observers have often found in the blood of the Dog, and which cannot be classed with the *Filaria immitis*. They were first noticed by Gruby and Delafond, and afterwards found by Lewis, Manson, Sonsino, Grassi, etc.

These embryos are about 280 μ long by 5 μ in diameter; they are slightly attenuated in front, and terminate behind in a very fine tail. They show a rudimentary digestive tube, and much resemble the embryos of the *Filaria immitis* (Fig. 323); they are more especially distinguished from them, however, in being able to attach themselves by their buccal extremity to the cover-glass or slide, and remain a long time fixed, while their body moves about in every direction; that extremity then appears enlarged, as if it were compressed (Lewis, Grassi).

The frequency of these embryos varies with the countries in which they are observed. In their examination of 480 Dogs, Gruby and Delafond found 1 affected in 20 to 25. Of 40 Dogs suffering from various diseases, Manson, at Amoy, China, discovered 13 with the embryos of Nematodes in their blood. At Pisa, Sonsino found them in the proportion of 7 in 20; and Lewis, at Calcutta, in 1 to 3. Grassi has also found these hæmatozoa in a great number of Dogs.

According to Gruby and Delafond, these worms are very vivacious, and are still movable ten days after the blood has been withdrawn from the vessels and kept in a vase at a temperature of 15° C. Their small diameter allows them to pass through the capillaries, so that they are found in venous as well as in arterial blood, though they are not met with in any other of the fluids in the body. Their number is considerable, and Gruby and Delafond were perhaps below the mark in approximately estimating them at from 11,000 to nearly 224,000; the average in 30 Dogs has been calculated at more than 52,000. In some instances there are seen 3 to 5, and in others as many as 12 or 15, in every drop of blood.

Although, in general, Dogs do not appear to be affected by these embryonic parasites, yet Gruby and Delafond report epileptiform attacks in three of these animals, two of which succumbed.

Gruby and Delafond believed they could trace the hereditary transmission of this helminthiasis; but in all the instances they could only find the Filariæ in the blood of the progeny when these were five or six months old; and as, in addition, these authorities imagined they could distinguish the maternal and the paternal heredity, there is reason to think the appearance was due to infestation of the young animals after birth.

By injecting defibrinated verminous blood into the bloodvessels of Dogs which were free from the parasites, in nine cases they noticed the disappearance of the microscopic Filariæ from the circulation in from eight to forty days; in two other Dogs they persisted for more than three years or until their death, and at the autopsy the adult worm was not to be found in the heart or vessels.

In recent years, the origin of the embryonic Nematodes of the blood has been the object of persevering researches by Lewis and Sonsino, but more especially by Grassi.

The latter, adopting the opinion abandoned by Lewis, at first thought they belonged to the *Spiroptera sanguinolenta*, as he believed he had found these hæmatozoa in Dog-Fleas (*Pulex serraticeps*); but be met with Dogs infested with Fleas, nearly all of which were full of Nematodes, and though these animals themselves had hæmatozoa in their blood, yet they did not harbour the Spiroptera. On the other hand, Dogs infested with the latter had neither hæmatozoa nor Fleas containing Nematodes. Otherwise, there is no concordance—neither in form nor development—between the larvæ found in Fleas and the embryos of the Spiroptera. It has been stated elsewhere (p. 314), that Grassi discovered that the real intermediate host of the *Spiroptera sanguinolenta* is the common Cockroach (*Periplaneta orientalis* Linn.).

The larvæ of the Nematodes—more than 50 of which may be counted in a single Flea—live as parasites in the intestine and abdominal cavity of that Insect. They agree exactly with those which Manson observed in Mosquitos, and which he regarded as belonging to the evolutive cycle of the *Filaria sanguinis hominis*.

Sonsino has found these same larvæ not only in the Fleas of Dogs, but also in their Lice (*Hæmatopinus piliferus*); and it is probable that it was this species that Bancroft in his observation relative to the Nematode parasites of a Dog-louse, thought was the *Trichodectes latus*, which he considered to be the intermediate host of the *Filaria immitis*.

Neither Grassi nor Calandruccio have confirmed Sonsino's observation respecting the part played by the Lice in this question. On the contrary, they have found embryonic Nematodes in Cat-Fleas (*Pulex serraticeps*), in those of Man (*Pulex irritans*)—which also live on the Dog—and in a species of Tick, the *Rhipicephalus sanguineus* (Latr.).

The embryos of the Nematodes, having reached the digestive passages of the Flea, pass through the walls of its intestine, and become encysted in the adipose tissue of the Insect—though they sometimes remain free in the cavity of its body. These embryos become larvæ, which pass through two or three successive phases of development, and acquire a length of 1·5 mm., and 30 μ to 35 μ in diameter, developing two or three papillæ around the mouth, and a much larger number at the anal extremity.

With the exception of Galeb and Pourquier, all those who have recognised the frequency of Nematodes in the blood of the Dog have remarked on the rarity of the *Filaria immitis* in the same countries. From several Dogs—at the autopsy of which he found the *Filaria immitis* in the heart—Grassi collected a great number of Fleas, and was unable to discover a single Nematode larva in their abdominal cavity.

From these considerations, it may be concluded that the Hæmatozoa of Lewis do not represent the embryonic form of a Nematode actually known in the adult state. Grassi and Calandruccio have given the name of *Filaria recondita* Grassi to the species—yet to be discovered—to which these worms belong; and they consider as an adult, but non-fecundated female of this mysterious species, a Nematode they once found coiled up in the midst of adipose tissue in the vicinity of the right hilum of the kidney of a Dog. It was 3 cm. long, and ·178 mm. in diameter; there were at least four very small papillæ behind the mouth; three papillæ at the posterior extremity—one terminal and two lateral; anus 228 μ from the caudal extremity; and vulva about 840 μ behind the mouth.

ARTICLE II.—Hæmatic Filariasis.

Filaria immitis (Leidy).—Body white, a little obtuse at the ends, the anterior being somewhat thicker than the posterior. Mouth surrounded by six small and not very distinct papillæ. *Male*, 12 cm. to 18 cm. long, tail tapering and closely spiral, with two lateral wings; 11 papillæ on each side, of which 6 are post-anal, and 1, 4, 5, 8, 10, and 11 are marginal, the others being near the middle line; while 1, 2, 3, 4, 5, 6, and 7 are very small, and on one side only there is a single pre-anal, marginal papilla. Two unequal spicules. *Female*, 25 cm. to 30 cm. long, and about 1 mm. in diameter; tail short and obtuse. Ovoviviparous.

FIG. 322.—Male and female *Filaria immitis*; natural size.—Railliet.

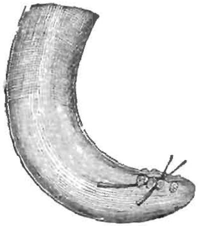

FIG. 323.—Caudal extremity of the male *Filaria immitis*; magnified 50 diameters.—Railliet.

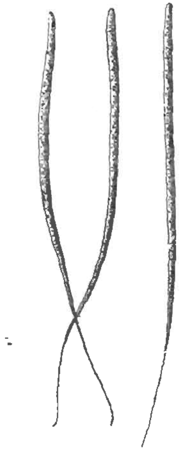

FIG. 324.—*Filaria immitis*. Embryos collected from the heart of a Dog; magnified 300 diameters.—Railliet.

This worm appears to have been seen for the first time by Panthot, in 1679; then a century later by La Peyronnie, in 1778. It has since been found by Peyson, Zeviani, Bobe-Moreau, Jones, and a number of other observers.

It chiefly inhabits the right heart and the pulmonary artery of the Dog.

It has been met with in various parts of Europe, from Denmark to Italy. Jones, Leidy, and Schuppert, have found it in the United States, and Silva Araujo at Brazil. It is very frequent in China and Japan; according to Somerville, it is scarcely possible to open a Dog which has lived for any time in China, without finding *Filaria immitis* in its bloodvessels or in the right ventricle of the heart. Friedberger, Reuther, and Deffke have observed this worm in Germany in Dogs which had lived for several years in China or Japan. On the other hand, Lewis, at Calcutta, did not find it in a single animal, although one-third of the Dogs there have embryonic hæmatozoa.

Symptoms.—The *Filaria immitis* does not often betray its presence by any appreciable disturbance to health; though its existence may be predicated by a microscopical examination of the blood, in which will be found embryos that have a very close resemblance to the Hæmatozoa of Lewis. They are, however, distinguished—according to Grassi—by their number, which is always more considerable, and by their never attaching themselves by their oral extremity to the slides or cover-glasses.

Manson states that the embryos of the *F. immitis* offer—though in a less degree than those of the *F. sanguinis hominis*—the curious peculiarity of abandoning the peripheral circulation during the day, and reappearing in it at night—or, rather, showing themselves in much greater number at that time; and Sonsino has verified this fact. In making the autopsy on Dogs which have been killed by prussic acid or strychnine, Manson has observed that the embryos accumulate in the large vessels of the thorax and abdomen during the day.

In the majority of instances, the worms are found at the autopsy of Dogs which have died after various morbid manifestations. Sometimes death is sudden, or has only been preceded for an hour or two by dyspnœa and convulsions. But more frequently the animal has exhibited for a variable number of days, dulness, debility, dropsy, and more or less frequent attacks of convulsions or epileptiform seizures; there are even occasionally rabiform symptoms (Osborne, Rivolta, Hoysted). Deffke has noticed symptoms of chronic interstitial nephritis; and Reuther has remarked pain on the inner surface of the thigh, with lameness—but no local lesion—atrophy of the whole upper part of the limbs, vomiting, paralysis, and death amid convulsions. De Montigny—formerly French Consul at Shanghai—informed Davaine, that, in China, Dogs affected with this filariasis became weak, and died vomiting blood. Leidy has noticed a frequent cough, and, after running, sudden insensibility and chill, though these were of short duration. Among the matters vomited by a Dog, he on two occasions found living Filariæ 15 cm. long.

Death is the usual result of hæmatic filariasis. In China, it kills

nearly all the European Dogs, and, as a consequence, these animals are very scarce and dear (Montigny).

Pathological Anatomy.—At the autopsy of Dogs which have succumbed to the disease, there are found in both cavities of the right side of the heart, and in the pulmonary artery for some distance from its commencement, the *Filaria immitis* in very variable number—perhaps only five or seven in some instances, or hundreds in others, as in the case reported by Mégnin. On the average, there is one male to two females; sometimes there are only males (cases reported by Manson and Silva Araujo), or only females (Manson).

The worms, especially if numerous, are interlaced in an almost inextricable manner, in one or more bundles, which obstruct the cavities of the heart by winding themselves round the *columnæ carneæ*. There is frequently hypertrophy of the heart, and more or less marked endocarditis and endarteritis; sometimes there is rupture of the myocardium and hæmorrhage into the pericardium and pleura. Zeviani and Silvestri have also found the worm in the left side of the heart; Schuppert met with it in the anterior vena cava, and Labat in the posterior vena cava; while Leidy observed it not only in the lungs, but also in the liver.

Ercolani was the first to remark, that when the Filariæ are found in the heart, they are also in the subcutaneous tissue of some region of the body; they are sometimes more frequent there than in the heart, from which they may be absent, and they are seen at various points—males or females—coiled up together, living or dead, or calcified. Rivolta, Vachetta, Lanzilloti-Buonsanti, and Grassi have corroborated this observation. Lanzilloti-Buonsanti has remarked that the Filariæ in the subcutaneous connective tissue are smaller than those in the heart; and he has also found in the intermuscular connective tissue, cysts containing both male and female young Filariæ.

When the worms exist in one of the numerous parts of the body which they may inhabit, their embryos are met with in the blood —provided, of course, that there are fecundated females, which there will not be if the males and females are isolated.

There may be other lesions subordinate to the presence of these worms. Labat has met with the parasites in the branches of the pulmonary artery of a Dog that died of unilateral pneumonia; they were more numerous in the affected lung than in the other. Leidy has noted hæmorrhage of the kidneys and bladder; Reuther, some tumours in the spleen; Lanzilloti-Buonsanti, white subpleural pulmonary nodules with a red point in the centre, which was occupied by embryos of the Filariæ—the nodules varying in size from that of a millet-seed to a pea; the same authority has also noted some alterations in the kidneys. Deffke has seen lesions of a gastro-intestinal and vesical catarrh; the kidneys showed those of chronic interstitial nephritis, more particularly affecting the glomeruli, which were atrophied, while the uriniferous tubes were dilated and varicose.

The pathogenic action of this Filaria commences with chronic endocarditis, embarrassed pulmonary circulation, and the development of embolism and thrombosis in the lungs. The embryos thrown out in the heart and pulmonary artery, are disseminated throughout the whole circulatory apparatus, and can be observed in various organs. The hypertrophy of the heart, and irregularity and insufficiency of the circulation, explain the occurrence of the digestive, respiratory, and urinary catarrhs; while anæmia of the nerve-centres brings about convulsions, sensory disturbance, paraplegia, and, finally, collapse. It is not very probable that—as Rivolta imagined—the embryos exercise an embolic action which causes hyperæmia of the brain and various organs, as the diameter of these embryos—which is not greater than that of the Hæmatozoa of Lewis—admits of their passing along the capillaries.

The alterations in the kidneys—which have been many times observed—are due, according to Deffke, to the great number of embryos which tend to be eliminated by the urinary passages—like those of the *Filaria sanguinis hominis*, which produce the chyluria or hæmatochyluria that is endemic in hot countries. Grassi formally contests the opinion that the embryos of the *Filaria immitis* are evacuated with the urine, and relies for proof on observations carried out for a year on one Dog, and for two months on four others, all of which were affected with hæmatic filariasis.

Etiology.—The etiology of this helminthiasis is still obscure. It is supposed that infestation takes place by the drinking-water, as is generally admitted it does with regard to the *F. sanguinis hominis*. Manson, a physician at Hong-Kong, has recognised that the embryos of the latter pass into the digestive tube of a Mosquito (*Culex mosquito*), when it sucks the blood of people affected with hæmatic helminthiasis. In this new *habitat* they undergo changes—the tail becomes shortened, the anterior part of the body is developed, and the sexual organs appear. These alterations are effected in about five days, and the Filaria then measures about 1 mm. At this period the Mosquitos have resorted to stagnant water to lay their eggs: there they die, and the Filariæ escape from their dead bodies, and live at liberty in the water. It is in drinking this water that Man becomes infested.

Grassi does not accept this opinion, and bases his objection on the circumstance, that the majority of the embryos of the *F. sanguinis hominis* which enter the intestine of the Mosquito perish there, and that scarcely 12 per cent. continue their development. He admits, also, that all the embryos of the *Filaria immitis* ingested by the Fleas and Lice of the Dog die in the intestine of these epizoa, the *rôle* of which is limited to relieving the mammal of a portion of its hæmatozoa. The latter are also eliminated by the various wounds of the skin that the Dog is exposed to—either in hunting, or running through gorse, brushwood, etc. But this elimination is nearly always insignificant, and Grassi's objections do not affect the question very much.

The *Filaria immitis* appears to belong more particularly to countries rich in marshes and surface-water ; and it might therefore be supposed that the intermediate host—crustacean or mollusc—through which this worm passes is concealed in the water, in an unknown form.

In pregnant Bitches which harboured the *F. immitis*, Galeb and Pourquier found its embryos in the blood of the fœtus, as in that of the parent. This fact tends to establish hereditary transmission of the parasite, by means of the placenta.

ARTICLE III.—Strongylosis of Blood-Vessels.

The Strongyle of vessels, the embryos of which give rise to pulmonary strongylosis of the Dog, lives in the right heart and pulmonary artery. It belongs essentially to the fauna of Toulouse, where it has been often met with. Beyond this region, the same (?) worm has been twice seen in Italy by Bossi.

Strongylus vasorum (Baillet).—Body filiform, a little attenuated at both extremities, white or rose-coloured, some individuals marked with a kind of reddish, spiral, and often interrupted line, which indicates the digestive tube, as seen through the integuments. Head bordered by two small wings—formed perhaps after death—which join in front ; mouth nude. *Male*, 14 mm. to 15 mm. long ; caudal pouch with two lobes, each sustained by four ribs, the anterior and middle of these being double. *Female*, 18 mm. to 21 mm. long ; vulva situated in front of the anus. Ova ellipsoïd, and 70 μ to 80 μ long, by 40 μ to 50 μ broad.

It was probably this worm which, according to Dujardin, was found in 1813, at Paris, 'in the heart' of a Dog. But the first precise mention of it is due to Serres. At the autopsy of a Dog which died suddenly, after having presented vague symptoms which were thought to be indicative of gastro-enteritis, the right ventricle was hypertrophied, and in its cavity and the right auricle were disseminated 'an infinity' of worms. Some of these were collected in small bundles the size of a pea, and the lumen of the pulmonary artery was almost entirely obstructed by them ; they extended as far as the last divisions of that vessel. A description of the case has been given by Baillet.

In the heart they are more especially located in the furrow separating the columnæ carnæ at the lateral borders of the ventricle, or beneath the tricuspid valve. They are most frequently met with in the larger divisions of the pulmonary artery, particularly at the origin of the collateral branches. They occasion an endarteritis in the form of granulations, layers, or resisting and anastomosing cords, amongst which they lie. The internal wall of the artery has a reticulated aspect, resembling that of the inner surface of the auricles. The smaller arteries are constantly affected with thromboses. The lumen of the vessel is filled by a hard and yellow clot, above which the Strongyles are accumulated. Laulanié has observed that the *Strongylus vasorum* determines—by the depo-

sition and dissemination of its ova—a pulmonary granulosis, the histological study of which is full of interest, and of which we have given a *résumé* (p. 511), as well as indicated the symptoms by which it may be manifested. But, with the exception of that of Serres, no cases in which the termination was fatal have been published ; in that instance the number of hæmatozoa was exceptionally high. Generally, the animals are killed after suffering for a long time.

Lafosse believed he had found good results in treating infested Dogs with oil of turpentine in 2 to 4 gramme doses made up into four pills, and given daily for a week. He mentions that two Dogs which offered the symptoms of this helminthiasis completely

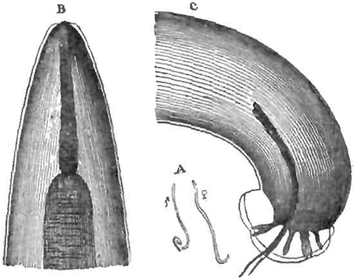

FIG. 325.—*Strongylus vasorum.*

A, male and female ; natural size. B, cephalic extremity ; magnified 100 diameters. C, caudal extremity of the male ; magnified 100 diameters. —Railliet.

recovered under this treatment. The symptoms consisted of marked oppression, fits of coughing, irregular—sometimes tumultuous—beating of the heart, a certain repletion of the jugulars, coinciding with unimpaired appetite and the absence of fever, all which symptoms, he says, were observed many times in animals which died or were killed, and in the heart of which this helminth was found at the autopsy. Labat—who in this strongylosis has noted, as a very distinct symptom, a soft systolic blowing in the femoral artery—has also in two Dogs obtained a recovery with Bordeaux turpentine, given every day in doses of 2 to 4 grammes in the form of pills, along with calcined magnesia, or in emulsion with yolk of egg.

ARTICLE IV.—**Spiroptera Sanguinolenta.**

The **Spiroptera sanguinolenta** (Rud.), which has a predilection for submucous tumours in the stomach or œsophagus, was found for the first time in similar tumours in the walls of the aorta by Morgagni and Courten in 1760. In France, it has only been seen on two occasions, by Mégnin and Chauvrat. 'For myself,' says Rayer, 'I have opened more than 300 Dogs, 127 of them specially with the object of finding these worms in the walls of the aorta, and I have not been able to discover a single instance of verminous nodule of that vessel.' On the contrary, Lewis at Calcutta, Manson at Amoy, China, and Silva Araujo in Brazil, have frequently seen it; and Oreste, Perroncito, and Caparini have observed it in Italy.

These verminous tumours occupy the thoracic aorta, and in size they vary between that of a small shot, a pea, nut, or walnut. They are separate, or joined in two or three. Their number is very variable; in the Dogs seen by Morgagni, in one case there were 3; in another 16; and in a third, the aorta, from its origin to the diaphragm, was studded with these tumours. They projected from the external surface of the aorta, and at the corresponding point the internal tunic showed a blood extravasation and slight abrasion. Then there occurs an arteritis, characterized by roughening of the lining membrane, and thinning of the walls of the vessel. In the smaller tumours the worms are still embryonic, and at the most 2·5 mm. long. After several moultings, they acquire all their external characteristics, as well as their genital organs. In the larger tumours, there are several well-developed parasites, more or less separated from each other in distinct compartments. The worm sometimes creeps along beneath the tunic of the aorta, and one of its extremities projects through a small opening, and floats in the interior of the vessel. Lewis has, in some instances, found the lumen of the aorta nearly obliterated by a clot formed around the worm. He had never observed the parasites in the abdominal portion of the aorta. Once, however, Morgagni found them in a tumour situated beneath the renal vessels, but it did not adhere to these, nor to any other vessels; and Mégnin has seen one in the posterior aorta, in the vicinity of the kidneys.

In the observations of Lewis and Manson, the aortic tumours often coincided with similar tumours in the œsophagus.

The contents of the verminous tumour may pass into the aorta by an easily discovered opening; but Lewis has never found the adult Spiroptera in the bloodvessels of the Dogs he examined—only the embryos. It is, therefore, the ova which pass from the tumours into the blood-current, and, within a variable time, effect their embryonic evolution. Lewis attempted some experiments in order to discover the migrations of these parasites; but they were unsuccessful, and the problem still awaits solution.

When they are of large size, the verminous tumours of the aorta

must cause serious disturbance in the circulation. Manson asserts that their possible rupture will bring on a fatal pleurisy, and he attributes to them a somewhat common paraplegia, which he thinks is due to the ova which have left the aorta and entered the capillaries of the spinal cord. Mégnin, Chauvrat, Perroncito, and Caparini have witnessed Dogs dying suddenly from hæmorrhage, owing to rupture of the artery, the walls of which had undergone atheromatous degeneration.

The *Spiroptera sanguinolenta* is sometimes also found in the lymphatic glands situated at the entrance to the chest, near the œsophagus or anterior aorta. Lewis, Caparini, Chauvrat, and Jacoulet have published instances of this occurrence ; and Jacoulet has noticed, in one case, great difficulty in swallowing, frequent vomiting, diarrhœa, and finally cachexia. In another case—which was that of a Dog that was killed because of the rabiform symptoms it presented—the worms were lodged in a bronchial gland, close to the œsophagus. The observation of Chauvrat (1890) is very analogous to this.

CHAPTER IV

HÆMATOZOA OF BIRDS

PROTOZOA.—Danilewsky, Grassi, and Feletti have discovered, in the blood of various birds, parasites closely related to those which cause paludism in Man, and which are known as the 'Bodies of Laveran' and *Plasmodium malariæ* (Ital.). Of the domesticated Birds, Pigeons are the only ones in which they have been observed (Grassi and Feletti).

According to Laveran, the hæmatozoon of paludism is unique, but polymorphous. Its various forms can be reduced to four: 1. *Spherical bodies* or very small *cytozoa*—1 μ to 2 μ—very difficult to distinguish in the interior of a red corpuscle of the blood—but sometimes larger, containing more or less pigment granules, and found either in the interior of a red corpuscle, or external and isolated, or in small groups; 2. *Flagella*, globular free bodies, from 5 μ to 7 μ in diameter, with pigment granules, and provided with 1 to 4 very mobile flagella; 3. *Crescentic bodies*, cylindrical elements from 8 μ to 9 μ long by 2 μ broad in their middle, more or less tapering at their ends, usually curved in crescent form, and generally containing in their middle portions grains of pigment, identical with those observed in the globular bodies; 4. *Rosaceous bodies*, arising from the segmentation of the endoglobular parasites, and giving origin to 8, 10, and often 20 spores, which become free.

These diverse forms have been found in the blood of Birds, but the cytozoa and crescentic bodies are the most frequent, the first being nearly always included in the red corpuscles. These blood parasites are only found in Pigeons during six or seven months in the year, infestation appearing to take place in the spring, and it increases by multiplication of the parasites; it disappears towards the month of November. But although the hæmatozoa of Birds are chiefly observed in marshy regions, they are generally completely innocuous to their hosts—a circumstance which is related perhaps, according to Danielwsky, either to accommodation transmitted by heredity, or to the temperature of the blood, which may be too elevated for the parasites to be set free.

Danilewsky has met with a Trypanosome (*Trypanosoma sanguinis avium*) in the blood of Birds, and a spirochæte (*Sp. Marchouxi*), which causes a very fatal disease of fowls in Brazil, has been described by Marchoux and Salembeni.

NEMATODES.—Mazzanti has found, in the venous blood of a carrier-Pigeon, the embryos of Nematodes, some of them 185 μ long, with an acuminated caudal extremity; others 143 μ long, with the caudal extremity obtuse or not very pointed. At the same time he met with, beneath the skin of the neck, a female Filaria—different from the *Filaria clava* Wedl—which lived in the connective tissue. The uterus of this Filaria contained a number of embryos identical with those in the blood; some of them were spread around the body of the female. Mazzanti describes this worm as follows: Body filiform, ashy-blue, not striped, 25 mm. long, and ·25 mm. wide; anterior extremity obtuse and rounded; posterior extremity briefly conical. Mouth nude and orbicular. Œsophagus short and narrow; stomach little dilated. Anus terminal. Uterus double. Vulva situated a little behind the position of the stomach, or 213 μ from the mouth. Ovoviviparous.

Rudolphi mentions—but without describing it—a *Filaria anatis* found by Paulinus rolled around the heart of a Duck.

BOOK VI

PARASITES OF THE MUSCLES, CONNECTIVE TISSUE AND BONES

IN this division—which is more especially devoted to the parasites of the muscles—we will also study those of the inter-organic connective tissue, as well as those of the bones; for the reason that they are too rare, and altogether of secondary interest to afford material for a distinct section.

The parasites to be dealt with in this book are varied and very frequent. They are the Sarcosporidia, Cestodes in the cystic state—Cysticercus and Cœnurus—Trematodes—*Distomum sp.* ?—or Nematodes, the most important of which is the Trichina.

They reach their definitive habitat through, as yet, badly defined channels, among which the circulatory system is doubtless the principal.

Special chapters are given to *Muscular Psorospermosis*—the Cysticerci—*Measles*—the Trichinæ—*Trichinosis*—and to the parasites of bones. The other parasites will be studied briefly, because of their relatively trifling importance.

Cœnurus cerebralis.—The Cystic form of the *Tænia cœnurus* of the Dog, the *Cœnurus cerebralis* Rud., the ordinary *habitat* of which is the brain of Ruminants—principally Sheep—has been found once in the subcutaneous connective tissue of a Calf by Nathusius, and at another time in the Sheep by Eichler. These erratic examples of Cœnurus were completely developed (Zürn).

Cœnurus serialis.—The Cystic form of the *Tænia serialis* of the Dog—the *Cœnurus serialis* P. Gervais—has, on the contrary, its usual habitat in the connective tissue of various regions of the body, and, exceptionally, the spinal cord. It is found in the Rabbit—especially the wild one—the Hare, the Squirrel (Cobbold, Cagny), and the Coypu (Pagenstecher).

The vesicle (or bladder) of the *Cœnurus serialis* may be as large as a Fowl's egg, but it has already numerous scolices when it is no bigger than a nut. It is generally a little longer than it is broad, and when it occupies the intermuscular connective tissue its greater axis is parallel with the fasciculi. The perfectly-developed scolices are three or four times larger than those of the *Cœnurus cerebralis*, and their free extremity is often Voluti-shaped. They are sometimes distributed without order, but most frequently they are

in linear series not parallel with each other—hence the specific name. The heads have all the characters we have indicated as pertaining to that of the *Tænia serialis* (see p. 376). The vesicle offers a peculiarity which is never present in the *Cœnurus cerebralis*—that of sometimes producing by budding, either on its inner or outer surface, other bladders organised like itself, and endowed with the property of originating scolices in every respect similar to those of the mother vesicle. The external vesicles often remain fixed to the mother-vesicle by a pedicle; but the internal ones, on the contrary, after a certain time float in the fluid of the primary bladder (Baillet).

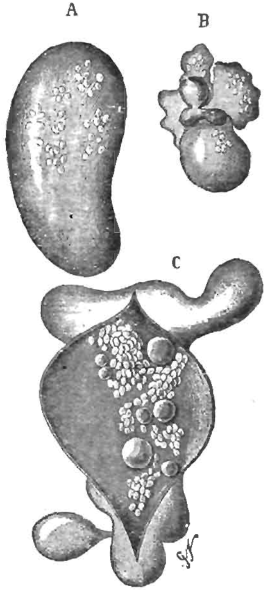

FIG. 326.—*Cœnurus serialis* of the connective tissue of the Rabbit.—Railliet.

A, regular simple form; B, daughter-vesicle, irregular exterior form. C, a Cœnurus opened, showing—besides the heads of the *Tænia*—seven internal daughter-vesicles, and below, to the left, an external daughter-vesicle. Natural size.

The *Cœnurus serialis* was met with for the first time by De Blainville in 1822; then it was re-discovered by Rose in 1833, and some time after by E. Rousseau, then by Gervais; but it has been well studied since, principally by Baillet and Perroncito. It has been found—and sometimes in great number, in the most varied parts of the connective tissue—head, neck, loins, thorax, limbs, etc. In general, it does not appear to trouble the health of its host. However, when it is very abundant—due to the budding of the mother-vesicle—it may assist in weakening the animal. Bergeon and Railliet have published a remarkable instance of this.

When Baillet administered the *Cœnurus serialis* to Dogs, it produced the *Tænia serialis*; Perroncito obtained the same result. And the ova of this Tænia, when given to Rabbits, reproduced the same Cœnurus; but when the experiment was repeated on Lambs by Baillet, it did not furnish conclusive results, and with Perroncito—who experimented on a Sheep—and ourselves with two Lambs, the results were negative. This confirms the specific distinction established between *T. serialis* and *T. cœnurus*.

The researches of Baillet show that the embryos of the Tænia are carried to the tissues by the blood-current. They pass through the walls of the capillaries, and excavate in the connective tissue 'galleries more or less elongated, and generally very tapering and fine at one end, wider at the other, which are always filled with a pulpy matter, unctuous to the touch, very pale-yellow in colour, and markedly distinct from the red background the small quantity of extravasated blood forms around it, after this has coagulated in the connective tissue.' In eighteen to twenty-five days after the ingestion of the ova of *Tænia serialis*, the pro-scolices form vesicles measuring ·75 mm. to 2·50 mm., and after thirty days they are the size of a pea. At the end of the second month they are larger than a cherry, and commence to bear scolices; at the third month they are as big as a walnut.

English gamekeepers designate as 'bladdery Rabbits' those affected with Cœnurus in the connective tissue, and—according to Rose—before they are sent to market, the bladders are punctured through the integuments, and the fluid they contain is in this manner got rid of.

'It should be remarked,' Baillet says, 'that the largest number of the cysts has been collected from wild Rabbits, and this would appear to indicate that the Tænia which produces them must inhabit the intestine of some carnivorous animal that usually lives in the same locality as these Rabbits; so that the development of this Tænia in the Dog must be considered purely accidental.'

Echinococci.—Echinococci are only exceptionally found outside parenchymatous organs—such as the liver, lungs, pancreas, spleen, etc., but they may be found in any part of the body. Nevertheless, beyond the cases we have quoted, in which they were generalized in the Pig, and that mentioned by Morot, in which hydatids were situated between the pleura and the inner surface of the ribs of a Cow, we know of only a small number of observations regarding their presence in the muscles; and what is remarkable in these, is the circumstance that they all refer to the Horse, in which Echinococci are rare.

In one of these cases, a handful of hydatids was lodged in an abscess in the temporal fossa. The temporal, pterygoid, and ocular muscles were softened and pale, and united by inflammatory tissue. The left wall of the cranium was thickened, and the left cerebral hemisphere compressed (Kirkman). In another case, the cyst—which contained a considerable number of hydatids—was situated between the wall of the thorax and the attachments of the diaphragm (Goubaux). In one more instance, a hydatid cyst formed a tumour in the region of the ribs, which persisted for seven years, and finally disappeared, after having thrown out on several occasions Echinococcus vesicles (Raymond).

In four other cases, the hydatids were located in the upper parts of the posterior limb. In one of them, they were acephalocysts enclosed in a large pouch, that formed a voluminous tumour

between the anus and ischium; the animal had experienced frequent attacks of colic. An incision through the wall of the rectum allowed the extraction of the hydatids, and this was followed by recovery (Villate). On another occasion the hydatids formed an enormous tumour in the lumbar region, having invaded the muscles there; this tumour was reproduced after being twice partially removed. It extended towards the ilium, and Echinococci were even found in the diploe of that bone (Colin). At the autopsy of a Horse killed because of incurable injury to its foot, Broquet and Mégnin found the muscles on the inner aspect of one thigh partly removed, owing to the presence of a large number of hydatid cysts, the vesicles of which varied in size from that of a pea to a pigeon's egg; there were about two quarts of them, and they belonged to the exogenous type. In the case reported by Ranvier and Dehors, the horse had been killed because of the low state into which it had fallen, and on examination there was discovered a vast purulent tumour, extending from the left kidney to the superior border of the ilium, formed of large irregular cavities, communicating with one another by various-sized openings. In the pus floated hundreds of Echinococci—intact and broken. This multilocular pouch was continued by a number of orifices into the deeper layers of the gluteal muscles, and those of the anterior and posterior crural regions. Johne found a vesicle in the psoas muscles of a Horse (Friedberger and Fröhner).

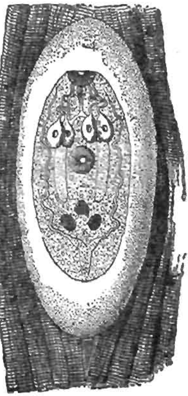

FIG. 327.—Distome of the muscles of the Pig; magnified 80 diameters. — Leuckart.

Distomum hepaticum.—Morot has published several instances of hepatic Flukes encysted beyond their ordinary habitat, in the Cow. On two occasions he found a tumour situated in an intercostal space, either between the internal and external intercostal muscles, or immediately beneath the pleura. In another instance, the Distomum was contained in a pediculated cyst on the inner surface of the abdominal wall, a short distance from the insertion of the diaphragm at the twelfth rib. The same author has also seen them on various points of the abdominal and pectoral walls. Drosse had already observed the same occurrence.

Distomes in the muscles of the Pig.—Leunis discovered particular Distomes in Pig's flesh, which were studied by Duncker, with the concurrence of Leuckart, Pagenstecher and Hess; they were found in the fleshy part of the diaphragm. Happen and Muhle have also seen them in the larygneal muscles.

These worms occupied ovoid cysts of about the same size as those of Trichinæ, and lodged in the interfascicular connective tissue. Owing to the inflammatory zone surrounding them, they appeared as small, red, punctiform nodules. The Distomes measure about 5 mm. long; they are grey, transparent, very lively

at the temperature of the body, and show at their anterior extremity an oral sucker, from which arises an acuminated prolongation directed forward, which is probably, according to Leuckart, a buccal stylet of the Cercaria.

The abdominal sucker is situated towards the middle of the body. The transparency of the integuments allows the arrangement of the digestive tube, the aquiferous vessels and the rudimentary genital organs, to be seen; as well as the presence of four large glands in the anterior moiety. Duncker on one occasion found these Distomes still provided with their cercarial tails. It is evident that these parasites are not called upon to continue their course of development in the Pig, for the membranes surrounding them are too strong to allow them to pass through. The Pig is only an intermediate abnormal host for them, and the state in which they are seen does not admit of their being assigned to any particular species.

Nematodes.—Several Nematodes have been found in the muscles and connective tissue of various domesticated animals. The most important—the Trichina—will form the subject of a special chapter (see *Trichinosis*); so that we will only now deal with those whose presence is exceptional or accidental.

The **Filaria papillosa,** which usually lives in the peritoneum of the Horse, is noticed by Rudolphi as also found in the sub-peritoneal and inter-muscular connective tissue of the abdominal walls of the same animal.

We have seen that the *Filaria immitis* may be found in the subcutaneous connective tissue of the Dog; that the embryos of the *Ollulanus tricuspis* of the Cat may wander from the stomach into the muscles and connective tissue, as well as into diverse organs, and form cysts analogous to those of the Trichinæ; and that larval Nematodes have been met with by Eberth in the muscles, kidneys and lungs of the Sheep.

Filaria clava Wedl.—Female worm found at Vienna in the peritracheal connective tissue of a Pigeon. Mouth unarmed; body attenuated in front, expanded behind and claviform; length 28 mm. to 36 mm., and diameter 1 mm. to 1·5 mm. Ovoviviparous. Mazzanti says he possesses a dozen specimens.

Zürn found in the flesh of three Pigs, small Nematodes which he believed to belong to the Augiostomidæ, and which should not be mistaken for muscle Trichinæ. Their maximum length was 1·4 mm. and breadth 63 μ; they were not encysted, and their presence was probably accidental; as it was thought they might have penetrated the specimens examined, by coming in contact with water or instruments containing them.

In a Horse killed for human consumption, which for at least eighteen months previously, though in excellent condition, had shown a certain stiffness in the hind-quarters and a great tendency to decubitus, Vittu found all the muscles invaded by cysts which were generally the size and appearance of a rye-seed. These cysts had undergone calcareous degeneration, and by their position in the interfibrillar connective tissue, the structure of their walls, and the mass of fat at their ends, they resembled old cysts of the *Trichina spiralis*. Giard, who studied them, was convinced that he had to do with a parasite related to the Trichinæ, though much larger; but perhaps there was more reason in classing it with the *Spiroptera reticulata*, of which mention will be made presently.

An analogous observation to that of Vittu, was made on a Cow by Wolff, at Berlin. He found the muscles of this animal full of nodules—some round and as large as a lentil, others oval and as big as a grain of rice. These nodules were situated between the muscular fasciculi, and were limited by a thick membrane; in their brown caseous contents Schütz found a coiled-up Nematode, a little larger than a Trichina.

The **Armed Sclerostome** (*Sclerostomum equinum*), which in the adult state inhabits the cæcum and large colon of Equines, is—in the agamous state—very apt to wander. Consequently, it has been on several occasions met with

in the muscles and connective tissue, where it arrives by means of the circulation. Harvey found not less than 200 specimens in the vicinity of the kidneys of a Foal; Litt, in 1852, met with hundreds in the connective tissue between the peritoneum and abdominal muscles; Meyrick, in 1859, observed the same in the peritoneal cavity, on the liver, and in the abdominal muscles; and Miller, at Seville, Ohio, collected considerable quantities in the abdominal muscles, and especially in those of the flank. Lastly, Liénaux on several occasions found them encysted beneath the peritoneum, in various parts of the abdominal walls, underneath the pleura, on the inner surface of the arms, etc. The Sclerostomes of the abdominal walls may cause the formation of small purulent centres around them (Railliet). Although agamous, these worms are sometimes larger than the adults.

Spiroptera reticulata Crep. (*Sp. cincinnata* Ercol., *Onchocera reticulata* Dies, etc.). — Body filiform, very elongated, and turned in a spiral manner. Head not separated from the body; mouth orbicular. *Male* in a wide spiral form; tail excavated beneath, and margined by two vertical lobes, the base of which has small hooks and the upper border a papilla; there is a single spicule between the two lobes. *Female in a close spiral form*; body attenuated behind; vulva situated at a short distance from the head. Ovoviviparous. The length of these parasites is not exactly known, as they cannot be extracted entire, in consequence of their being rolled around muscular and tendinous fibres. The female appears to measure from 40 to 50 centimetres long, and from ·35 mm. to ·40 mm. in diameter, which is ·15 mm. in the male. This worm is special to Equines, and was discovered in 1840, by Hermann and Bleiweiss, at the Vienna Veterinary Institute. It was afterwards found

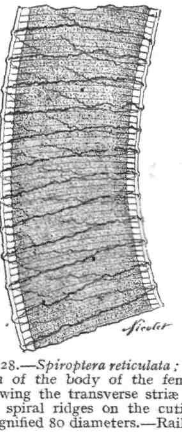

FIG. 328.—*Spiroptera reticulata*; portion of the body of the female, showing the transverse striæ and the spiral ridges on the cuticle; magnified 80 diameters.—Railliet.

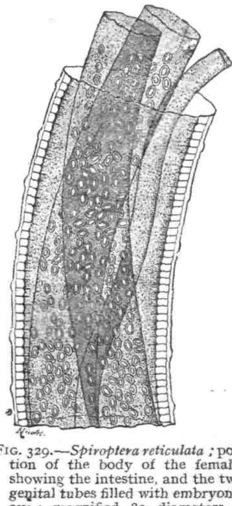

FIG. 329.—*Spiroptera reticulata*; portion of the body of the female, showing the intestine, and the two genital tubes filled with embryonic ova; magnified 80 diameters.—Railliet.

in Germany and Austria, by Gurlt, Baumgarten and Zürn; in Italy, by Ercolani, Bassi, Gotti, Baruchello, Berto and Vigezzi; in Russia, by Tschulowski and Popow; and in France, by Railliet and Moussu.

It has been sometimes observed in the cervical ligament or in the tissue of neighbouring arteries, between muscular fibres, and in subcutaneous nodules; but it has been most frequently met with in the flexor tendons of the foot, the suspensory ligament of the fetlock, and in the walls of the collateral artery of the cannon.

FIG. 331.—Ova of the *Spiroptera reticulata*; magnified 200 diameters.—Railliet.

It is very common at Kazan, as Tschulowski found it in fifty-one of the fifty-three Horses in which he looked for it.

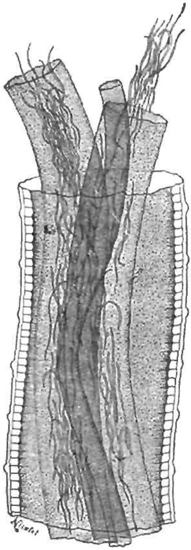

FIG. 330.—*Spiroptera reticulata*; portion of the body of the female, showing the intestine and the two genital tubes filled with embryos; magnified 80 diameters.—Railliet.

FIG. 332.—Embryos of the *Spiroptera reticulata*; magnified 200 diameters. —Railliet.

It has been met with at all seasons of the year—but more particularly in the spring and summer—and in Horses of every age.

Its most frequent seat—and also the most important, but it is betrayed by significant symptoms—is in the limbs, and almost exclusively in the anterior ones. Its presence causes the formation of isolated tumours—parasitic fibromata—which are seen in the region of the tendon—within, without, or behind the perforatus

tendon; at the knee—within or without, or in the neighbourhood of the insertion of the flexor of the metacarpus; at the external or posterior surface of the fore-arm; at various points of the shoulder and arm, etc.

These tumours compress the nerves or tendons; hence there results persistent, acute or sub-acute lameness, the cause of which often remains unknown, so long as the parasitic fibroma has not acquired an appreciable size.

Treatment consists in extirpation of the tumour; this leaves only a simple wound that is easily healed.

The extracted tumour is, in general, irregularly ovoid in shape, and from 3 cm. to 6 cm. long. It is composed of dense fibrous tissue which is often calcified, and surrounds yellowish nuclei, in the centre of which is found the worm, which up to the present time has only been extracted in fragments.

In Horses which were bearers of the reticulated Spiroptera, Tschulowski has sometimes found an abundance of their embryos in the lymphatic vessels of the limbs, in the perivascular connective tissue, in the synovia of the three inferior articulations, and in bursæ of tendons—especially in the bursal distensions popularly known as 'wind-galls.' These embryos were very slender, and measured 300 μ to 400 μ long by 6 μ to 9 μ broad; throughout their whole length was remarked a digestive tube filled with a granular matter. This observation tends to establish the fact, that the embryos of the *Spiroptera reticulata* may effect active migrations, and may even enter the vascular system.

CHAPTER I

PSOROSPERMOSIS OF THE MUSCLES AND CONNECTIVE TISSUE

THE Sporozoa which inhabit the muscles and connective tissue form the order of SARCOSPORIDIA or PSOROSPERMIÆ UTRICULIFORMES. They are divided into three genera, according to the following table :

Seated in the connective tissue. Enveloping membrane thin and without definite structure	. . . . . .	*Balbiania.*
Seated in the striped muscles } thin and anhistic	. . .	*Miescheria.*
Enveloping membrane . } thick and traversed by fine canaliculi		*Sarcocystis.*

The Sporozoa of the domesticated animals belong to the genera **Balbiania** (Blanch.) and **Sarcocytis** (Ray Lank.).

The Sarcosporidia—which are also frequently named the *Utricules of Miescher* or *Rainey's Corpuscles*—were seen for the first time in 1843, by Miescher, of Bâle, in the muscles of the Mouse. Herbst afterwards found them in those of the Pig in 1851. Von Hessling, who in 1846 had observed them in the breast-muscles of a Roebuck, discovered them also in the myocardium of the Ox, Calf and Sheep ; and Rainey, in 1857, saw them in the muscles of the Pig. They have since been met with in the majority of the domesticated Herbivora—Horse, Ox, Buffalo, Sheep, Goat and Rabbit ; and amongst Birds, in the Fowl.

We may, at least provisionally, attach these Sarcosporidia to three distinct species : **Sarcocystis Miescheri** (Ray Lank.), **Sarcocystis tenella** (Raill.), and **Balbiania gigantea** (Raill.). But with the exception of the Pig, the Sarcosporidia of which are well known, there are too few observations recorded to allow of a rigorous determination of the species of parasite being made. This summary study of Psorospermosis will be divided into Psorospermosis of the muscular tissue and Psorospermosis of the connective tissue.

ARTICLE I.—Muscular Psorospermosis.

PIG.—The muscular psorosperm of the Pig is the *Sarcocystis Miescheri*. First observed by Herbst, then by Rainey in the muscles of this animal, it has since been studied by numerous observers, and is now well known, owing more especially to the investigations of Leuckart and Manz.

It is only at an autopsy that the presence of these parasites can be ascertained. All the striped muscles may be infested by them, and these have then a granular aspect and darker colour; while a close inspection discovers small white, elongated points in the midst of the muscular tissue, which are sometimes so long as to be readily seen. These are the Sarcocysts.

They may be as much as 2 mm. to 3 mm. long, and their breadth varies between 80 μ and 300 μ. They appear in the microscope as elongated bodies, slightly refrangent, granular, and tapering at both ends—though sometimes only at one. They are limited by a somewhat thick enveloping membrane, showing a transversal striation that Leuckart ascribes to the presence of numerous canaliculi; by compression this wall becomes disaggregated, and then appears as a ciliary covering, which some authorities have regarded as a normal arrangement in the Psorospermiæ. The interior of the Utricle is divided into a great number of spaces by anastomosing partitions. Towards the extremities, the membrane seems to be slightly separated from its contents, and a conical space is seen there, containing refrangent granules. For the remainder of its extent, the

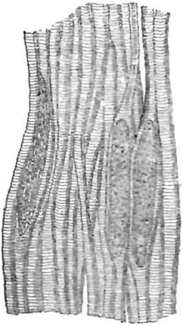

FIG. 333.—Psorospermic Utricles in the intermuscular fibres of the Pig.—Railliet.

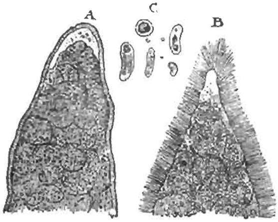

FIG. 334.—Psorospermic Utricles of the Pig; isolated and highly magnified.—Railliet.*

* A, extremity of a Utricle, the cuticle of which is intact; B, another Utricle, the cuticle of which is crushed and appears as cilia; C, reniform corpuscles and separate nuclei.

Utricle holds in its spaces spores—numerous and closely-packed corpuscles which, when they are set free by the rupture of the membrane, appear semi-lunar, reniform, or fusiform in shape. They have one or—more frequently—two clear points that are generally regarded as nuclei.

The Sarcocysts are situated even in the axis of the primary fasciculi, surrounded by a layer of the substance of which these are composed, and which has been pushed beneath the sarcolemma by the pressure of the parasite. The majority of authorities do not mention any other alteration than the dilatations and moniliform aspect of the primary fasciculi. According to Perroncito, the Utricles may move in the interior of the sarcolemma and leave

evident traces of their passage. When they are old they may undergo calcareous degeneration.

Laulanié has noticed that, while in certain points the invaded primary fasciculi remain healthy, at others they undergo vitreous degeneration, the parasite acting there as an irritant to the connective tissue. The primary fasciculi most distant from the centre are at first atrophied, and there sometimes appear new-formation cells; so that parenchymatous myositis is added to interstitial myositis.

Muscular psorospermosis is not betrayed during life by any appreciable signs. Nevertheless, Virchow has observed, in some Pigs which were affected, feebleness or intermittent paralysis of the hind-quarters, ardent thirst, a nodular exanthem, transient symptoms of 'rouget,' and in one instance lachrymation and a dull appearance of the eyes—

FIG. 335.—Transverse section of a group of primary fasciculi of the Pig, one of which is occupied by a Sarcocyst.—Laulanié.

a, section of the parasite; *b*, its contractile sheath formed by the substance of the primary fasciculus pushed beneath the sarcolemma; *f*, primary facsiculus.

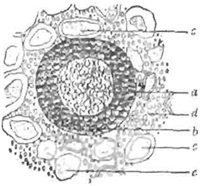

FIG. 336.—Psorospermic granule of the muscles of the Pig, at its commencement.—Laulanié.

a, transverse section of the Psorosperm; *b*, purulent corona; *c*, *c*, atrophied primary fasciculus; *d*, embryonic infiltration.

which might be due to the presence of the parasites in the ocular muscles.

The Sarcocysts of Miescher are very frequent—at least, in certain countries and at certain periods. Herbst estimates the number of instances in which he has found them as 50 per cent., and a similar estimate has been made by Rupprecht. Leuckart has found five Pigs affected out of eighteen, and Moulé has seen about 40 per cent.

The attempts at transmission made by Virchow and Manz, in feeding animals with pig-flesh infested with Psorospermiæ, were without result. Leuckart appears to have been more fortunate, for to a Pig—the muscles of which were free from these parasites (as was proved on examination of them by means of the harpoon)—

he gave the flesh of one that was infested. The animal was killed six weeks after receiving the first meal, and its muscles were full of very small-sized Psorospermiæ. But it cannot be concluded from this unique instance that the Sporozoa of the muscles can be directly transmitted through the digestive organs, and that the ingestion of infested flesh is dangerous for Man. Lindemann has, however, published a case in which Psorospermiæ, developed in the valves of the heart of a Man, caused a fatal dropsy. But in every case in which flesh is much infested, its use for human food should be prohibited, because of its bad appearance and diminished nutritive value—due to alterations which inflammation has pro-

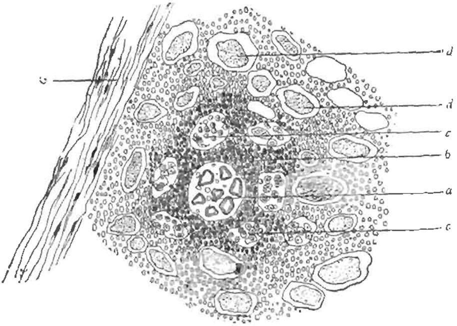

FIG. 337.—Completely developed psorospermic granule in the Pig's muscle, the parasite having disappeared in the middle of the degeneration of products.—Laulanié.

a, central zone represented by a small centre of calcareous degeneration ; *b*, peripheral zone of embryonal proliferation ; *c*, *c*, spaces originally occupied by the primary fasciculi, and now filled with cells ; *d*, *d*, atrophied primary fasciculi buried in the proliferation ; *e*, connective tissue septum.

duced in it. Rabe has published a case of serious intestinal catarrh in a Man, consequent on eating the flesh of a Pig that was intensely affected with muscular psorospermosis.

SHEEP.—Psorospermosis of the muscles of the Sheep is produced by the *Sarcocystis tenella*. It has often been observed, and is the form best known, thanks to the researches of Huet and Moulé. It occupies in the muscles of the Sheep the same situation that the *Sarcocystis Miescheri* does in those of the Pig—that is, the primary fasciculi ; but it is distinguished from it by the greater thinness of its enveloping membrane, which is otherwise canaliculated and capable of being reduced to pseudo-cilia by compression.

Moulé has often found the parasites in cachectic Sheep—98 per

cent.—and they were usually numerous in proportion as the cachexia was more accentuated. Sometimes there were regularly five, six, and more in the field of the microscope in each preparation; at other times several preparations would have to be examined in order to find one. In 100 Sheep in good condition, he only met with them in 44, and then always in small number. It was the same with a Sheep which had been affected with anthrax, the few which were observed appearing deformed.

They may be found in all the muscles, but they seem least numerous in those of the internal crural region. Von Hessling, Cobbold, Moulé, and Sticker have seen them in the myocardium; Brusaferro in the fibres of Purkinje of the heart; and Krause in the ocular muscles.

GOAT.—Moulé classes with the *Sarcocystis tenella* the Sarcosporidia he found in the Goat, which had been already seen by Pagenstecher. They are less common, and not so abundant as in the Sheep; for the proportion of cases has only been 46 per cent. in lean animals, and 33 per cent. in those which were fat. They are larger than those of the Sheep, and may be even double their size.

OX.—Sarcosporidia have been seen in the Ox, in the muscular fibres of the heart, by Von Hessling, Cobbold and Perroncito; in the muscles of the eye by Krause; in the cremaster of a Bull by Manz; and in various muscles by Beale. Of 100 Oxen condemned for being in extremely bad condition, Moulé found 37 of them infested with Sarcosporidia; he only found them in three instances in Cattle in good condition. These were probably the *Sarcocystis tenella*: they are of the same dimensions as those of the Goat, but may attain a centimètre in length, and have longer cilia—*Sarcocystis hirsuta* Moulé.

HORSE.—The muscle Sarcosporidia of the Horse are, doubtless, also the *Sarcocystis tenella*. They have been seen by Siedamgrotzky, Schulze, Pütz and Moulé.

Siedamgrotzky found Sarcosporidia in thirteen Horses killed for anatomical purposes, or which had died from different diseases. They were principally in the muscular layer of the pharynx and œsophagus, in the inferior cervical muscles, and in the diaphragm. In the limbs, the infested muscles were atrophied, pale, soft, and yet more fibrous than in the normal state. The nuclei of the sarcolemma were multiplied in the primary fasciculi affected, and even in the healthy fasciculi; they formed a kind of chaplet lying alongside the sarcolemma. In addition, the interfascicular connective tissue had undergone proliferation, and by compression had caused simple atrophy of the contractile fibre. These Sarcosporidia were from 3 mm. to 4 mm. long, and in some points had submitted to calcareous degeneration.

Schulze has met with these parasites in the muscles of the forehand of a Horse, killed because of being affected with paralysis of the anterior limbs. These muscles were degenerated, and showed calcareous granules 20 mm. long by 3 broad. Their elements had undergone alterations analogous to those observed by Siedamgrotzky.

In a Horse observed by Pütz, the majority of the muscles were more or less invaded—sometimes in a high degree—by Psorospermiæ of various ages. They—the muscles—were more voluminous and more rigid than in the normal state, and were of a yellowish-grey colour; there was interstitial myositis, proliferation of the interfascicular connective tissue, increase of the perimysium, and atrophy of the primary fasciculi, the striation of which, nevertheless, generally persisted. There was not always an exact relationship between the muscular alterations and the topographical distribution of the Sarcosporidia; so that there might have existed doubts as to these parasites being the real cause of this myositis.

Of 65 Horses examined by Moulé, 13 showed the Sarcosporidia ; but only one had them as large as those of the Ox ; in the others they were invisible to the naked eye.

OTHER SPECIES. — Sarcosporidia have been noted by Krause in the muscles of the eye of the Dog and Cat ; by Manz in various muscles of the Rabbit ; and by Kühn in those of the Fowl.

FIG. 340.—Fragment of the œsophagus of the Sheep invaded by the *Balbiania gigantea* ; natural size.—Railliet.

ARTICLE II.—**Psorospermosis of the Connective Tissue.**

The Psorospermiæ of the connective tissue are the *Balbiania gigantea* Raill. They were first met with in the Sheep by Winckler and Leisering, then by Dammann,

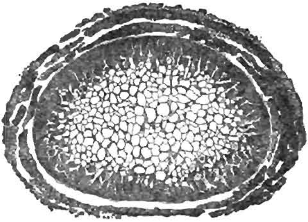

FIG. 338.—Transverse section of a *Balbiania gigantea*, enveloped by muscular fibres of the œsophagus ; magnified 20 diameters.—Railliet.

Zürn and Brusaferro, and have been well studied by Morot and Railliet. Von Niederhœusern has seen them in the Goat ; and Jongh has often observed them in the Ox, Deer, Goat, Pig, and especially the Buffalo, at Java. According to certain observers,

FIG. 339.—Falciform corpuscles of the *Balbiania gigantea* ; magnified 850 diameters.—Railliet.

it would appear that they may also be met with—like the preceding—in the midst of the primary fasciculi.

The size of a *Balbiania gigantea* may vary from that of a barley-grain to that of a small hazel-nut. The enveloping membrane is thin and structureless, and in the centre of the largest specimens is a space as large as a pin-head. The remainder of the cavity—which is partitioned into cells—is filled with very regular crescentic-shaped corpuscles, which have no nuclei and do not refract the light. Certain of the Balbianiæ only show a few corpuscles, but have many round bodies, which have a greater or less diameter in proportion to the maximum thickness of the crescents.

The German authorities, who were the first to observe these Sarcosporidia, found them in great numbers in the muscular layer of the œsophagus, and, secondarily, at the base of the tongue, in the muscles of the pharynx, cheeks, neck, thorax, abdomen and thighs. The Sheep which were the bearers sometimes died suddenly, at other times after manifesting symptoms of asphyxia or epileptiform seizures. In some instances the mortality was like that of an epizooty, and the losses were attributed to the action of the Sarcosporidia, which, by their presence in the vicinity of the larynx, caused œdema of the glottis and, consequently, asphyxia. Von Niederhœusern, who found them in a Goat, arrived at the same conclusion.

But the investigations of Morot certainly seem to establish that there is a simple coincidence between the fatal issue and the psorospermosis of the œsophagus, as he very often found these parasites in Sheep killed at Troyes abbatoir. Moulé has not met with any in Paris, but Raillet has discovered them there in a Goat.

In about 900 Sheep, Morot found 272 which had the œsophageal cysts of the Sarcosporidia. Neither the condition, age nor sex appeared to have any influence on their presence or number, which latter varied from 1 to 272, and averaged from 10 to 12. The same Sheep might have them of all sizes, these having no relation to their number.

'Among the 272 Sheep which had the œsophagus nodulated, 6 had at the same time psorospermic cysts beneath the pleura, 10 beneath the peritoneum, and 27 beneath the pleura and peritoneum at the same time.' These subserous cysts were 'usually in the form of elongated patches, the dimensions of which varied from that of a cabbage-seed to that of a prune-stone, and even that of an average haricot-bean.' They were sometimes more, at other times less numerous, than those of the œsophagus.

A Sheep of second quality and in good condition had a large number in every part of the body, and especially in the œsophagus, which had 227, and the tongue, which harboured 128. Some were found in the muscles of the subscapular and crural regions.

CHAPTER II

MEASLES

Definition.—Measles (French *ladrerie*) consists in the presence of certain Cysticerci in the muscles and connective tissue, and accessorily in other parts of the organism. The Cysticerci which constitute the disease are: the *Cysticercus cellulosæ*—the cystic form of the *Tænia solium* of Man; the *C. bovis*, of the *T. saginata* of Man; the *C. tenuicollis*, of the *T. marginata* of the Dog; the *C. tarandi*, of the *T. Krabbei* of the Dog.

The domesticated animals which may contract the measles are—in the first line—the Pig (*C. cellulosæ*), then the Ox (*C. bovis*), and exceptionally the Sheep (*C. tenuicollis*), the Reindeer (*C. tarandi*), and the Dog and Cat (*C. cellulosæ*). Man himself is not exempt from this affection (*C. cellulosæ*).

ARTICLE I.—Measles of the Pig.

The Pig measles is produced by the *Cysticercus cellulosæ* Rud., the larval form of the *Tænia solium* of Man.

History.—Measles of the Pig has been known from the earliest times, and its influence on human health seems to have inspired the Egyptian priests in the days of the Pharaohs and of Moses—the law-maker of the Jews—when they prohibited the use of the flesh of that animal as food. But the first mention of this disease occurs in the fourth century before our era, and is found in the writings of Aristophanes (B.C. 450-380), where, in his comedy of *The Knights*, it is spoken of as being well known. Aristotle has described it with remarkable precision, and his description has been almost exactly reproduced by Rufus—quoted by Oribasius; then it is mentioned by Pliny and Didymæus, and again by Plutarch, Aretæus, Archigenes and Androsthenes.

Numerous laws enacted during the Middle Ages prove that it was also well known then, but there was as little idea of its parasitic nature as among the ancients, and we must come to the year 1683 before an indication of this is found in a memoir by Redi. Two years afterwards, Hartmann found a Cysticercus in a Goat, and recognised it as a living animal; but to Malpighi belongs the credit of giving the first exact description of the measle Cysticercus. These observations appear to have been little known, however; for it was not until 1760 that Pallas attempted to establish a relationship between the parasite of measles and the Tape-worms, and named it the *Tænia hydatigena*. About the same time, Fabricius expressed the opinion that the measle Cysticerci were derived from a Tape-worm; and Gœze, in 1780, described the bladder-worm with much precision and exactitude.

The year 1842 marked an important advance, as Steenstrup then con-

sidered the cystic worms as the first step in the development of Helminthes, which, however, he could not determine; while Von Siebold regarded them as

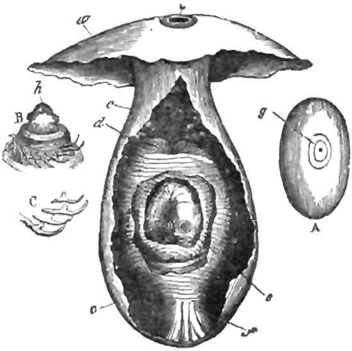

FIG. 341.—*Cysticercus cellulosæ.*

A, an entire vesicle magnified; B, proboscis with hooks at its base; C, isolated hooks; C′, fragment of a Cysticercus highly magnified: the vesicle is only represented by a segment, *a*, corresponding to its invagination orifice, *b*.—Robin.

wandering Tæniæ—an opinion also adopted by Dujardin in 1845. But it required the experiments of Van Beneden and Küchenmeister to put the migrations of the Cestodes beyond doubt, and the facts they established have been confirmed, extended and completed by numerous experimenters to whom we shall have to refer hereafter.

FIG. 342.—Head of the *Cysticercus cellulosæ*, seen in front, the suckers not being salient.—Railliet.

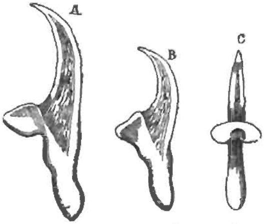

FIG. 343.—Hooks of the *Tænia solium*; magnified 250 diameters.—Railliet.

A, large hook; B and C, small hook seen laterally and in front.

Pathological Anatomy.—It is more especially at an autopsy that the existence of measles is recognised, from the presence of the

Cysticercus cellulosæ Rud. in different parts of the economy. It appears in the form of an elliptical vesicle from 6 mm. to 20 mm. long and 5 mm. to 10 mm., or even more, broad ; and showing towards the middle of its length a white spot provided with a scarcely visible opening, that corresponds to the invaginated head. The latter has at first the aspect of a white, opaque, and somewhat consistent tubercle, the size of a millet-seed, which adheres to the wall and projects internally. By methodical pressure between the thumb and forefinger, it is easy to extrude the head and body of the Cysticercus from the caudal vesicle, in which they are invaginated ; usually the vesicle, is ruptured in this operation. On examining the evaginated head by a low magnifying power, it is observed to be sensibly tetragonal, and to measure ·6 mm. to ·8 mm. ; it is furnished with four suckers, and a double crown of from 24 to 32 hooks, the larger of which are 160 μ to 180 μ long, and the smaller from 110 μ to 140 μ. These are absolutely the characters of the head of the *Tænia solium* of Man.

Each Cysticercus is enveloped in a cyst, the dimensions of which are scarcely superior to its own ; this cyst is formed at the expense of the tissues of its host, and is composed of a thin, transparent, connective-tissue membrane, slightly vascular, and destitute of epithelium. The cysts are lodged in depressions—cells or alveoli excavated in the substance of tbe organs.

The measles Cysticerci are found almost exclusively in the muscular masses, the muscles most frequently invaded being those of the tongue, the neck, and the shoulders ; then come—in the order of frequency—the intercostal and psoas muscles, those of the thigh, and, lastly, those of the posterior vertebral region (Delpech). The measles is sometimes so generalized that Cysticerci are met with in all the striped muscles of the body ; their number may be enormous, and equal to almost one-half the total volume of the piece of flesh examined. Küchenmeister has found 133 in a scrap weighing 17 grammes—which would give about 8,000 to the kilogramme.

When the measles is not very pronounced, the vesicles are scattered, but they have always their privileged seat in the muscles of the deeper surface of the shoulder, in those of the neck, the fleshy portion of the diaphragm, the triangularis sterni, and the intercostals. It is necessary, in some of these discrete invasions, to make numerous sections in various directions, in order to find a single vesicle. By squeezing the flesh between the fingers, we may often succeed in rendering some visible, which would otherwise remain unperceived ; and frequently, also, measly flesh may be recognised by the little cavities from which the Cysticerci have been removed.

Sometimes the parasites are found in the submucous connective tissue on the inferior surface of the tongue, nearly as frequently as in the above-mentioned muscles. Towards the base of that organ and the sides of the frænum, they are usually seen as opaline,

semi-transparent, globular or ovoid vesicles, which raise the mucous membrane, and can be felt by the finger.

The heart is also very often invaded by Cysticerci, and at times in such numbers that there is reason for wonder that the functions of the organ are not seriously interfered with. When there are only a few, they are usually localized towards the point.

It is rare to find them in the fat, but when the disease is generalized they may be met with in the neighbourhood of muscles, adhering to the muscular fibres that enter the layers of adipose tissue.

Otherwise, the specks or grains (as they appear to the naked eye) may be found in all the organs—brain, spinal cord, eyes, lungs, liver, kidneys, spleen, lymphatic glands, and testicles (Cobbold); but they are rarely in notable quantity, though Brusaferro has observed them in large number in the cerebral hemispheres, but not in any other parts of the organism. They are exceptional in the liver, lungs, spleen and kidneys (Hertwig). In the majority of instances in which they were supposed to have been seen, they were really old Echinococci, and not Cysticerci. In the lungs, liver or spleen, they sometimes form grey or reddish, caseous, purulent or calcareous nodules, which have some resemblance to tubercles, and in which an attentive examination will lead to the discovery of hooks, and even of complete heads of the Cysticerci (*Gratia*).

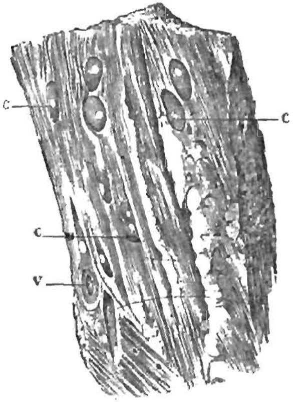

FIG. 344.—Fragment of measly muscle from the Pig.—Railliet.

c, *c*, Cysticerci; *v*, alveolus from which the bladder-worm has been removed.

The cysts containing the measles Cysticerci are lodged either on the surface or in the substance of muscles, between the secondary fasciculi, and parallel to their direction.

Occasionally the parasites have lost their usual characters, owing to degeneration, which may occur at any stage of their development; their size is then between that of a millet and a hemp seed. They form elliptical nodules of a yellowish-brown colour, filled with yellow purulent matter, in which neither the scolex nor even the hooks are to be found (Munkenbeck).

It is usually age that brings about degeneration of the Cysticerci, and their transformation into small, round, hard and compact grains, impregnated with calcareous matter and destitute of fluid. The pork-butchers then name the disease *dry measles*. It is almost certain that, when in this condition, the parasites are dead. This form of measles is rare in Pigs brought to the Paris market, but it is somewhat common at Bordeaux (L. Baillet).

The degeneration of the Cysticerci is centripetal—that is, it begins with the external membrane and finishes with the scolex; and this is most evident in the caseous or pseudo-purulent degeneration.

The pressure exercised by the cyst is frequently the beginning of atrophy in the secondary fasciculi. Later, the interfascicular connective tissue becomes thickened, and forms streaks like bright veins in marble, which grow more and more marked (Trasbot).

The muscles infested by measles are pale and soft, and in cutting into them the Cysticerci are opened, which causes a copious flow of limpid, amber-coloured serum. But if the disease is of long standing and generalized, the anæmia with which it may then be accompanied gives rise to a passive infiltration into dependent parts, while the muscles themselves are impregnated, and often show, in addition, the *Sarcocystis Miescheri*.

There is, besides poverty of blood, tumefaction and infiltration of the lymphatic glands, pallor of organs, and the lesions of concomitant affections which have caused death.

The Cysticerci will be absent from the surface of the muscles when the pork-butcher has scraped them off with his knife; they have been, as it were, enucleated, but attentive examination will discover the small cavities they occupied, and all doubts may be removed by cutting into the suspected piece, for it is rare not to find other vesicles in its substance.

It is very difficult to meet with the Cysticerci in chopped-up pork, because of the small fragments of fat intimately mixed up with it. Schmidt-Mülheim recommends, in such circumstances, a procedure based on the resistance of the Cysticercus to the gastric juice.

The gastric mucous membrane of a Pig or Dog is chopped into small pieces, and macerated for some hours in a 5 per thousand solution of hydrochloric acid; then the fluid is filtered, and must be used within a brief period. But if it is desired to have a fluid that will keep for some time, so as to be ready for any emergency, a different course will have to be adopted. The chopped mucous membrane is steeped in glycerin for several days, and then filtered; this fluid will keep for years at the ordinary temperature. When it is to be used, a few drops are thrown into a 5 per 1,000 solution of hydrochloric acid, and a sufficient quantity of the suspected sausage or chopped pork to be examined is digested for several hours at a temperature of 40° Cent., in six to eight times its volume of a mixture of pepsinized glycerin and acidulated water, being shaken from time to time. The flesh and fat are dissolved, the latter appearing as a more or less thick layer on the surface of the liquid. The vesicle of the Cysticercus is slightly attacked, but the head and suckers, and especially the crown of hooks, resist the action of the fluid, fall to the bottom of the vessel, and are easily found in the form of grains resembling rice.

Symptoms.—The symptoms of measles are very vague and difficult to appreciate, while they vary according to the susceptibility of the animals and the particular localization of the malady. Most frequently they are null, and especially when infestation is not general. Of all those which have been indicated, the only one that may be accepted as pathognomonic is the presence of the Cysticerci beneath the mucous membranes accessible to exploration—such as the inferior surface of the tongue, and more especially on the sides of the frænum ; sometimes on the conjunctivæ, and more rarely in the folds of the rectum. At these points, their presence may be recognised by the unevenness of the surface of the membrane, and the prominences more or less marked which the vesicles form, while their distinctly transparent and opaline aspect contrasts with the rosy tint of the adjacent parts.

If vesicles are observed about the tongue, the existence of measles is certain, though if they are not found there, the absence of the disease must not be inferred ; for of 41 cases of measles discovered after death during one quarter of the year, L. Baillet noted 10 in which there was no trace of Cysticerci in the lingual region. This practical result shows that in litigation between buyer and seller, the fact that the mouth of the animal had been inspected before purchase would not be a proof in favour of the vendor.

The vesicles in the mouth, conjunctivæ and anus, may be removed by a trifling operation named 'pricking' (*épinglage*), which consists of either a simple puncture that empties the Cysticercus, or an incision that allows of its removal. There remains a small wound which suppurates for a short time, and which might be ascribed to an injury caused by the teeth or some hard body—such as a bone. When these wounds are healed, they leave a small temporary cicatrix, which cannot serve as an aid in *ante mortem* diagnosis.

Except for the presence of Cysticerci beneath the visible mucous membranes, there are no other signs that permit the disease to be recognised in the living animal—though a good number have been mentioned as belonging to it ; but they are exceptional or of little value, and are only seen in animals which are very largely infested. Such is hoarseness, accompanied by a small, suppressed husky cough, and a tendency to breathlessness—symptoms very probably due to the presence of numerous Cysticerci beneath the mucous membrane and in the muscles of the larynx.

Greve says he has remarked in many measly Pigs an increased sensitiveness in the snout which prevents their burrowing, even in soft ground ; and in eating grain off a hard floor they avoid contact with that part as much as possible, by raising the nose and upper lip, and seizing the food with the tongue. Tapped slightly on the end of the nose with a stick, the measly Pig cries out because of the pain, while a healthy Pig would remain indifferent. Very measly Pigs have the snout more or less tumid, soft and flaccid. But these indications have not been confirmed by other observers. It is

the same with regard to a certain degree of analgesia or anæsthesia of the skin of which some writers have spoken, and also the bristles being easily pulled out and a drop of dark blood at their root—symptoms alluded to by Aristotle.

Many pig-dealers and butchers assert that measly Pigs have the shoulders high, whence results a cramped appearance of the neck and stiffness in movement of the anterior limbs ; this may be due, as Trasbot remarks, to an abundance of Cysticerci in the large pectoral and great serratus, etc., muscles, which become relaxed, and allow the thorax to descend between the shoulders.

In a Pig suffering from intense measles, Sobotta observed complete paralysis of the tongue, which was invaded by Cysticerci ; the prehension of food was therefore impossible, and the animal perished from inanition.

When the Cysticerci are located in the nerve-centres, the symptoms often assume a particular physiognomy. Florman has seen very manifest circling movements in such a case ; and Rehrs has witnessed epileptiform convulsions, grinding of the teeth, ptyalism, pleurothotonos and opisthotonos, with rabiform vertigo. At the autopsy, he found in the cerebrum and cerebellum an enormous quantity of Cysticerci, several of which were of exceptional size. In similar cases, rabiform symptoms have also been noted by Foucher. Neubert has seen vertigo and a kind of blindness ; the brain was softened, and contained more than a hundred Cysticerci. In a case observed by Lippold, the Pig died after presenting all the symptoms of encephalitis ; twelve Cysticerci were found in the pia-mater.

When the affection is chronic, extensive and generalized, the Pigs are feeble and easily put out of breath. They become indifferent, walk slowly, and have much difficulty in following the herd ; later they fall into such a state of prostration that they will not get up. Infiltration occurs in dependent parts of the body and beneath the mucous membranes ; the appetite diminishes ; diarrhœa sets in ; the pulse is feeble and quickened ; the mouth is pasty and fœtid ; and the gums are pale, spongy and bleeding. The animals lose condition, and become, as it were, blown out ; they appear paralyzed, and finish by dying, if, through negligence, they are not killed earlier.

The progress of the disease is subordinate to the number of parasites lodged in the tissues of the Pig ; it is also related more especially to the possibility of infestation and when the etiological conditions upon which this depends persist, it may be inferred that the symptoms will attain their greatest intensity.

Diagnosis.—The disease may have to be recognised in the living animal, or after its death. In the first case, the symptoms above enumerated are to be remembered, and especially the evidence furnished by inspection of the tongue.

The *post mortem* diagnosis—which is the most usual—often requires great attention. As Morot remarks, the facility of this

diagnosis is in direct relation to the extent of the muscular surfaces examined. The measly Pig may only show very few 'grains'—perhaps only one: and this may not always be recognised, notwithstanding the most minute and complete examination practicable at the abbatoir, and this even on animals passably measly.

In such a diagnosis, care must be taken to guard against mistaking other alterations in the flesh for this one, and what we have said with regard to the Distomes and Sarcocysts of Miescher should suffice to prevent errors. It will be seen hereafter that measles should not be confounded with trichinosis or with muscular actinomycosis.

The Ecchinococci which have remained small in size have been mistaken for Cysticerci; but their presence in parenchymatous organs rather than in the muscles, and a microscopical examination, should lead to their recognition. We have spoken of the resemblances which Cysticerci of the lungs have to the lesions of tuberculosis.

The *Cysticercus tenuicollis*—a parasite of the peritoneum—may be found fixed on the muscular portion of the diaphragm, and if it be of small size might suggest the idea of measles. But an error will be avoided if the quite superficial situation of this parasite is noted, as well as its distinct prominence, and sometimes the short pedicle that sustains it; the measle Cysticercus is always markedly sub-peritoneal, and more or less fixed in the muscular tissue; large *Cysticerci* accompanying the small ones (*C. tenuicollis*) show their real nature; there are no measle vesicles in the muscles, and, lastly, the characters of their hooks differ from those of *C. cellulosæ*.

There are found in Pig flesh, especially—and perhaps exclusively—in that which has been salted or smoked, small white concretions, from the size of a millet-seed to that of a pea, round or irregular, hard, and grating under the scalpel. They are composed of guanine, according to Virchow; of tyrosine, according to Voit, who is of opinion that they are formed during salting or smoking. They have no trace of parasites—Cysticerci or others—and are dissolved in hydrochloric acid without disengagement of gas, and in sulphuric acid without formation of sulphate of lime; they are dissolved in caustic potash, and fuming nitric acid also dissolves them into a yellow fluid, which, on the addition of potash solution, assumes a fine red colour over heat.

They are also found in smoked American hams—whether trichinosed or not—very refrangent globular corpuscles, of a radiating structure, and with a dark centre. They are probably formed of lime and a fatty acid, and should consequently become transparent by the addition of hydrochloric acid.

Etiology.—It is now well established that the essential and exclusive cause of measles, consists in the ingestion of the ova of the *Tænia solium* by the Pig. It is also proved by numerous experiments that the *Tænia solium*, or solitary worm of Man, is derived from the measle Cysticercus taken with pig-flesh.

Van Beneden was the first to cause a Pig to swallow the ova of *T. solium*, and at its autopsy he found a great number of Cysticerci in the muscles. Another Pig of the same litter, reared and fed under the same conditions as the preceding, but which had not received any ova of the Tænia, had no Cysticerci.

Küchenmeister and Haubner first, Leuckart next, and C. Baillet, Gerlach, Mosler, and others afterwards, repeated and varied these experiments, and always had the same results—thus incontestably establishing the origin of measles in the Pig.

When the ripe ova of the *Tænia solium* arrive in the digestive canal of the Pig, their shell is dissolved by the gastric and intestinal juices, and the embryos they contain are set free. By means of their six hooks, they pass through the walls of the stomach or intestine, and become dispersed—probably through the blood circulation—into every part of the body. They are arrested in the interfascicular connective tissue of the muscles, in the brain, spinal cord, and, in general, in all the organs favourable to their evolution. Their presence causes a slight irritation, and the accumulation of anatomical elements destined to form the connective tissue of the cyst, as well as to furnish the Cysticercus with the materials necessary for its development. The latter is not completely achieved until about the end of three months, according to the experiments of Gerlach. Mosler states that the Cysticerci only measure at the ninth day ·033 mm. in diameter; at the twentieth day they are the size of a pin's head, and have no cystic membrane; at the fortieth day they are as big as a mustard-seed, their envelope is very thin, the head is apparent, and the suckers and double crown of hooks are recognisable; at sixty days they are the size of a pea, the suckers and hooks are completely formed, but there is no neck. In about three months, their development is accomplished, but the caudal vesicle is still capable of growth. At 110 days the neck shows transverse stripes.

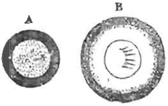

FIG. 345.—Ovum of the *Tænia solium*; magnified 350 diameters. Laboulbène.

A, ovum in glycerin; B, the same after being treated with a concentrated solution of potash.

Gerlach has remarked that the ingestion of too many ova of the Tænia may cause intestinal irritation in the Pig, which will terminate in death.

The innumerable quantity of ova that a single proglottis will furnish, explains the generalization of infestation, which is facilitated by their resistance to destructive influences; as they can remain intact for a long time in the ground, manure-pits, pools of water, etc., and it is in the latter that the Pig may find them when they have been washed therein by rain. The habits of that animal and those of the rural population among which it lives, are conditions eminently favourable to infestation. In the country, the human ordure is usually deposited out of doors, especially in

manure-pits, to which the Pigs have free access, and where they can eat the excrements ; so that one person infested by the Tape-worm is in this way capable of infesting a whole herd of Swine. Mosler relates the history of a person who infested 15 Pigs, these having broken through a fence that enclosed the privy.

All Pigs have not the same aptitude in contracting this disease. Haubner ascertained that measles infestation is very difficult, if not impossible, in aged Pigs ; and Gerlach came to the same conclusion. They are most liable to be infested when they are under six months old.

Breed cannot be considered as predisposing to the disease. If the higher-bred Pigs are less subject to it than common-bred ones, this is exclusively due to the different conditions under which they are respectively reared. For this reason, the Pigs of certain countries are more exposed than others. Measles occurs frequently in Ireland, Slavonia, certain parts of North America, France and Germany.

According to Kniebusch, measles does not exist in the Servian and Roumanian Pigs known as *Bakonyer*, which are fed on maize ; neither is it seen in Mecklenburg Pigs of English stock, which are reared on beans and peas. On the contrary, it is very common in Polish and Pomeranian Pigs fed on house-slops, scraps from the table, and potatoes (R. Blanchard).

Of 149,500 Pigs inspected in the district of Cassel, from 1872 to 1874, 153 were measly—or 1 in every 946 (Leuckart). From 1876 to 1881, of 15,937,000 examined, 48,880 were measly—or 1 in 326. Statistics show that the disease is less extensive in South than in North Germany (Zundel). In 1876, it was found in 163 of 10,000 Pigs—or 1 in every 307. On the other hand, Mosler's statistics give 9 well-measled Pigs in 20,000—or 1 in 2,222 ; but one-eighth of these harboured some Cysticerci. Leuckart—who furnishes these different figures—estimates that in certain parts of Germany there is measles—limited or generalized—in 2 or 3 per cent. of the Pigs.

In Italy, according to Pellizzari, the number of measly Pigs is generally 1 in 3,000 to 4,000 ; while Perroncito states that, from the informatiou furnished by the mouth-inspectors, there is at Turin 1 measly Pig in every 250, and at Milan 1 in 70 (Leuckart).

All these figures show that measles is not rare, and that it may be found in every country ; though it is much less prevalent now than formerly, as its nature is better known, inspection of meat has been instituted, and the rearing of Pigs receives more attention.

Prognosis—Noxiousness of the Flesh of Measly Pigs.—The prognosis of measles is always serious, inasmuch as no treatment can be prescribed for its cure. But there is no reason why this should be attempted, as it would not be economical. So that its prophylaxis is really what ought to occupy attention. Continual confinement to the sty, and feeding exclusively with materials free from the ova or proglottides of the Tænia—such are the best

preventive means. But in countries where agricultural necessities require that the Pigs be sent to the pastures, woods, marshes, etc., we must expect the disease to be maintained, unless the rural population is enlightened as to the danger that results from the dissemination of human excrement, and the necessity for well-closed privies.

The gravity of the prognosis is subordinate to the degree of infestation, and to the power of resistance of the individuals infested. When speaking of the symptoms, it was remarked that all degrees are compatible with an appearance of perfect health to the most pronounced cachexia.

The real seriousness of the prognosis is allied with economic considerations—measly flesh is dangerous to people who consume it, and its use should therefore be prohibited.

Küchenmeister was the first to publish an experiment, tending to prove that the measles Cysticercus of the Pig is transformed into the *Tænia solium* in the intestine of Man.

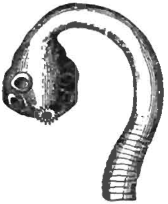

FIG. 346. — Head of the *Tænia solium*, seen three-quarters face.—Laboulbène.

FIG. 347.—Head of the *Tænia solium*, seen in profile.—Laboulbène.

In the three days preceding the execution of a woman condemned to death, she was made to swallow at several times 75 measles Cysticerci. At the autopsy, made forty-eight hours after death, he found 10 young Tæniæ, 4 mm. to 8 mm. long, some of which already carried several hooks.

The same authority had afterwards occasion to repeat this experiment under more favourable conditions. Another person condemned to death was, at Küchenmeister's request, on two occasions—one four months and the other two and a half months—before execution, given 20 measles Cysticerci. At the autopsy he found 19 Tæniæ, 11 of which had already mature proglottides.

On August 10, 1855, a young Man took voluntarily, in tepid milk, four completely developed Cysticerci, divested of their bladder. On October 25, Leuckart, who directed the experiment, discovered the first proglottides in the fæces, and on five different occasions afterwards they were found. On November 26, a double dose of kousso caused the expulsion of two Tæniæ about eight feet long.

Humbert, of Geneva—quoted by Bertolus—swallowed 14 measles Cysticerci; three months afterwards he suffered from Tæniæ, and passed considerable fragments, which Professor Vogt recognised as belonging to the *Tænia solium*.

Hollenbach—quoted by Leuckart—having taken some measles Cysticerci in a spoonful of coffee, in five months passed a portion of Tænia five feet long, with numerous segments, but no head. Although this worm was said to be the *Tænia serrata*, there can be no doubt that it was the *Tænia solium*.

Heller relates that a phthisical patient took 25 measles Cysticerci. He died in about eighteen days, and at the autopsy there were found twelve heads of the *Tænia solium*, which were still very small, and did not present to the naked eye any traces of segmentation.

These various experiments, so demonstrative, are in harmony with the observations concerning the frequency of *Tænia solium* in Man, this corresponding to the prevalence of measles in the Pig. This Tænia is not observed in Jews, Mussulmans, or other people who abstain from swine's flesh; nor is it seen in the torrid zone, where Pigs cannot be reared. This intestinal parasite of Man is otherwise becoming more and more rare, as the custom of properly cooking the flesh of the Pig is becoming generalized, while it is also subjected to a severe surveillance in the abbatoirs and markets. In France, the progressive diminution of cases of *T. solium* is remarked upon by numerous observers—Laboulbène, Bérenger-Féraud, etc.—and it is the same elsewhere in Europe. There is another Tænia—the *T. saginata*—which is now nearly everywhere more frequent; though, according to Leuckart, the first still predominates in some parts of Germany where Pig-breeding flourishes and pork is largely consumed—such are Thuringia, Saxony, the Duchy of Brunswick, Westphalia, Hesse, and Wurtemberg.

The *T. solium* is more especially met with in persons whose business brings them in contact with raw pork—butchers, cooks, sausage-makers, etc.—as they often hold the knife they use in their mouth; they may in this way receive the Cysticerci, which are reduced to small size by rupture of their caudle vesicle. Their tæniasis is also doubtless owing to their generally pronounced taste for raw pork.

The largest number of cases of *Tænia solium* are found in countries where raw pork is eaten. In France, infestation most frequently occurs through insufficient cooking of this flesh.

Measly pork has characters which should suffice to render its consumption repugnant. When cooked, it is pale, moist, and irregularly tinted. The Cysticercus, reduced to its body, is the size of a hemp-seed; it cracks between the teeth, and gives a disagreeable sensation. In roasting this flesh, it often crackles, from rupture of the measles vesicles. It has a sweetish taste, which renders it acceptable to certain persons.

The power of resistance of the Cysticercus to an elevated temperature is not considerable; but its deep situation in the flesh protects it during the process of cooking. Numerous experiments have been made, with a view to ascertain the degree of resistance of the Cysticercus. The most recent and precise are those of Perroncito. By means of Schultze's heating-plate, he was able to recognise exactly the vitality of the parasite by the movements of the rostellum, and to determine the temperature at which death

arrives. He was also able to recognise when death occurred, by the facility with which the tissues imbibe the neutral tincture of carmine and the tincture of hæmatoxylin. Lastly, he acquired proof of death by the voluntary ingestion of these Cysticerci by his assistants. In this way he was able to ascertain that the death of the Cysticercus sometimes takes place at 40° Cent., more frequently at 47°, and usually at 48°; though it may live at 49°, and quite exceptionally at 50°. But death is certain if it is kept for more than a minute at the latter temperature.

The practical difficulty is in knowing under what conditions the centre of the piece of flesh will reach this destructive temperature. In cooking large pieces of meat, Küchenmeister had noticed that after half an hour, when the external temperature was 60°, *the interior had reached* 55°; in about three-quarters of an hour the exterior was 77-80°, and the interior 63°. In experiments made at Lille in 1863, a ham cooked by boiling for two hours, was 58° in parts near the surface, and only 33° in the central parts. Another ham cooked in the same way for six hours, was 75° on the surface and 65° in the interior.

Pellizzari, using measly flesh, put two pieces, weighing 600 grammes, and 10 cm. thick, in boiling water, one piece for five minutes, the other for half an hour. When removed, one was 45·5° in the centre, the other 81°; taking into account the loss of heat by radiation, these two temperatures may be estimated at 51° and 83°.

From these experiments and others made by this authority, as well as those of Cobbold, Lewis and Perroncito—besides those which will be alluded to when dealing with trichinosis—it may be concluded that, in a relatively short period, cooking may act on different points in a piece of meat at a temperature above 50°, and so destroy the vitality of the Cysticerci.

For roasted flesh, Vallin has found that, while its external temperature necessarily exceeds 100°, beneath this superficial layer it is 'touched' by cooking, a layer beneath this again oscillates between 52° and 53°, but in the centre it does not exceed 46° to 48°. In comparing these figures with those Perroncito gives for the destruction of the *Cysticercus cellulosæ*, we may conclude that flesh, even when conveniently roasted, is still likely to produce tæniasic infestation; but it is more especially with underdone meat that there is danger.

With regard to preserved pork, there is no precise information. There is reason to doubt the correctness of the report by Weinland, that English soldiers during the Crimean War contracted Tapeworm from eating salt pork. Perroncito's investigations show, however, that the Cysticercus may yet be alive in flesh which has not undergone putrefaction, more than twenty days after the Pig has been killed. But it may be generally admitted that proper salting and prolonged smoking will destroy the vitality of the Cysticerci.